

BROAD AGENCY ANNOUNCEMENT (BAA)

OVERVIEW INFORMATION

The Air Force Office of Scientific Research (AFOSR) manages the basic research investment for the U.S. Air Force (USAF). As a part of the Air Force Research Laboratory (AFRL), AFOSR's technical experts foster and fund research within the Air Force Research Laboratory, universities, and industry laboratories to ensure the transition of research results to support USAF needs. Using a carefully balanced research portfolio, research managers seek to create revolutionary scientific breakthrough, enabling the Air Force and U.S. industry to produce world-class, militarily significant, and commercially valuable products.

To accomplish this task, AFOSR solicits proposals for research through this general Broad Agency Announcement (BAA). This BAA outlines the Air Force Defense Research Sciences Program. AFOSR invites proposals for research in many broad areas. They are described in detail in Section I, Funding Opportunity Description.

This announcement will remain open through the remainder of FY07 or until replaced by a successor BAA. Proposals may be submitted at any time during this period. However, those planning to submit proposals should consider that AFOSR commits the bulk of its funds in the Fall of each year.

AFOSR will not issue paper copies of this announcement. AFOSR reserves the right to select and fund for award; all, some, or none of the proposals in response to this announcement. AFOSR provides no funding for direct reimbursement of proposal development costs. Technical and costs proposals, or any other material, submitted in response to this BAA will not be returned. It is our policy to treat all proposals as sensitive competitive information and to disclose their contents only for the purposes of evaluation.

1. Agency Name

Air Force Office of Scientific Research
875 North Randolph Street, Suite 326
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2. Funding Opportunity Title

Research Interests of the Air Force Office of Scientific Research

3. Announcement Type

Broad Agency Announcement (BAA)

4. Announcement Number

BAA 2007-1

5. Catalog of Federal Domestic Assistance (CFDA) Numbers

12.800

6. Response Dates

This announcement remains open until superseded. Proposals are reviewed and evaluated as they are received. Proposals may be submitted at any time during the year.

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I. Funding Opportunity Description

AFOSR plans, coordinates, and executes the Air Force Research Laboratory's (AFRL) basic research program in response to technical guidance from AFRL and requirements of the Air Force; fosters, supports, and conducts research within Air Force, university, and industry laboratories; and ensures transition of research results to support USAF needs.

The focus of AFOSR is on research areas that offer significant and comprehensive benefits to our national warfighting and peacekeeping capabilities. These areas are organized and managed in three scientific directorates: Aerospace and Materials Sciences, Physics and Electronics, and Mathematics, Information and Life Sciences. The research activities managed within each directorate are summarized in this section.

Aerospace and Materials Sciences (NA)

The Directorate of Aerospace and Materials Sciences is responsible for research activities in aerospace, engineering, and materials. The four major projects in the directorate are solid mechanics and structures, structural materials, fluid dynamics, and propulsion. An equally important mission of the directorate is to support multidisciplinary efforts to meet Air Force science and technological needs. The structural materials activities in the directorate and the chemistry activities supported by the Directorate of Chemistry and Life Sciences form an integrated AFOSR structural materials program. The control theory and mathematical modeling research supported by the Directorate of Mathematics and Space Sciences complements many structural, fluid mechanics, and propulsion research programs supported by this directorate. Research areas of interest to the Air Force program managers are described in detail in the Sub areas below.

Structural Mechanics

The objective of this research program is to support fundamental studies in enabling structural technologies for future Air Force systems. Fundamental studies that will enable the Air Force to maintain the integrity and functionality of existing aerospace structures, as well as enhance their performance are also of great interest. Proposals are sought for studies into the synergetic exploitation of large nonlinear structural deformations under coupled fluid, thermal, and mechanical loads in quasi-static and dynamic regimes. Examples include, but are not limited to, novel actuation devices, the exploitation of aeroelastic phenomena for flapping-wing micro air vehicles, the prevention and control of nonlinear and aeroelastic phenomena, energy harvesting from environmental air turbulence and structural vibration, etc. Flexible load-bearing skins and reconfigurable support structures for smart and adaptive morphing aerospace vehicles are of interest. Novel structural concepts that support air- and space-based applications are of interest at any scale (nano, MEMS, large deployable structures) and for any purpose (sensing, control, stiffening, actuation, etc.). Structural health monitoring, nondestructive

evaluation, diagnostics and prognosis, and other concepts that contribute to the sustainment of structural reliability, survivability and mission readiness, especially under extreme environments, are of continuous interest. Other structural innovations in USAF-relevant areas not specifically mentioned above are also welcomed. White papers are encouraged as an initial and valuable step prior to proposal development and submission. The white papers that are found of interest will be encouraged to develop into full proposals.

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Mechanics of Multifunctional Materials & Microsystems

The main goals of this program are to establish safer, more durable aerospace vehicles and platforms with improved performance characteristics; and to bridge the gap between the viewpoints from materials science on one side and structural engineering on the other in forming a science base for the materials development and integration criteria. Specifically, the program seeks to establish the fundamental understanding required to design and manufacture new aerospace materials and microsystems for multifunctional structures and to predict their performance and structural integrity based on mechanics principles. The multifunctionality implies coupling between structural performance and other as-needed functionalities such as electrical, magnetic, optical, thermal, biological, and so forth. Structural integrity includes durability, survivability, reliability, and maintainability. This program thus focuses on the developing new design criteria involving mechanics, physics, chemistry, biology, and artificial intelligence to model and characterize the processing and performance of multifunctional materials and microsystems at multiple scales from atoms to continuum. Projected Air Force applications require material systems and devices capable of sustained performance in complex or hostile loading environments. Such systems and devices often consist of different materials with different functionalities. Examples include hybrid structural materials, multi-directionally reinforced composites, reactive multi-constituent materials, functionally graded material systems, and a variety of microsystems. New innovative material systems and devices, such as autonomic materials, active nanocomposites, and micro/nano-electromechanical systems, are also of strong interest. Interaction with Air Force Research Laboratory researchers is encouraged to maintain relevance and enhance technology transition.

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Boundary Layers and Hypersonics

The boundary layers and hypersonics portfolio is focused on providing the fundamental fluid physics knowledge base for future aerospace systems. Through

a balance of experiments, analytical modeling, and numerical simulations a fundamental understanding of critical fluid dynamic phenomena is achieved. Research supported by this program enables methods for flow prediction and optimization that, in the short-term, will reduce the weight, cost and fuel-consumption of future systems, and in the long-term, will enable completely new, revolutionary vehicle designs.

The behavior of the boundary layer impacts the aerodynamic performance of systems across all speed regimes of interest to the Air Force. The development of accurate methods for predicting the behavior of transitional and turbulent boundary layers across a wide range of flow conditions will facilitate the design of future systems with optimized performance and fuel-economy. To help accomplish this goal, research is solicited that will provide critical insight into the fundamental physical processes of laminar-turbulent transition and turbulent flows. Improved turbulence modeling approaches are sought for the prediction of flow and heat transfer in highly strained turbulent flows. In this context, original ideas for modeling turbulent transport, especially ideas for incorporating the physics of turbulence into predictive models are sought. Within the scope of this research thrust, aero-acoustics research focused on the impact of turbulence on jet mixing and noise will also be considered.

Hypersonic aerodynamics research is critical to the Air Force's renewed interest in long-range and space operations. The size and weight of a hypersonic vehicle, and thus its flight trajectory and required propulsion system, are largely determined by aerothermodynamic considerations. Research areas of interest emphasize the characterization, prediction and control of high-speed fluid dynamic phenomena including boundary layer transition, shock/boundary layer, and shock/shock interactions, and other phenomena associated with airframe propulsion integration. Real-gas effects, plasma aerodynamics, magnetohydrodynamics, and heat transfer in high-speed flows are also of interest.

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Unsteady and Rotating Flows

Research in unsteady and rotating flows seeks to advance fundamental understanding of complex time-dependent flows, their interactions and control, by creatively integrating theoretical, numerical and experimental analysis techniques to develop physically based predictive models and innovative concepts. This wide-ranging research encompasses both internal and external flows at micro-scales through supersonic velocities.

Research areas of interest include the characterization, prediction, and control of flow instabilities and fluid-structure interactions in both bounded and free-shear flows, including aero-optics, flapping wings, vortical flows and flows in turbomachinery and cavities; innovative flow effectors for both passive and active flow control, including fluidic thrust vectoring, internal duct flow tailoring, enhanced jet mixing, high lift, and drag reduction; innovative approaches to dramatically alter

convective heat transfer; innovative techniques for subsonic flow compression without machinery; and novel approaches for extracting flow energy.

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Combustion and Diagnostics

Fundamental understanding of the physics and chemistry of multiphase, turbulent reacting flows is essential to improving the performance of chemical propulsion systems, including gas turbines, ramjets, scramjets, pulsed detonation engines, and chemical rockets. AFOSR is interested in innovative research proposals that use simplified configurations for experimental and theoretical investigations.

The highest priorities are studies of supersonic combustion, atomization and spray behavior, fuel combustion chemistry, supercritical fuel behavior in precombustion and combustion environments, plasma-enhanced ignition and combustion, and novel diagnostic methods for experimental measurements.

In addition to achieving fundamental understanding, AFOSR seeks innovative approaches to produce reduced models of turbulent combustion. These models would improve upon current capability by producing prediction methods that are both quantitatively accurate and computationally tractable. They would address all aspects of multiphase turbulent reacting flow, including such challenging objectives as predicting the concentrations of trace pollutant and signature producing species as products of combustion. Approaches such as novel subgrid-scale models for application to large eddy simulations of subsonic and supersonic combustion are of interest.

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Space Power and Propulsion

Research activities fall into three areas: nonchemical orbit-raising propulsion, chemical propulsion, and plume signatures/contamination resulting from both chemical and nonchemical propulsion. Research in the first area is directed primarily at advanced space propulsion, and is stimulated by the need to transfer payloads between orbits, station-keeping, and pointing, including macro- and nanosatellite propulsion. It includes studies of the sources of physical (nonchemical) energy and the mechanisms of release. Emphasis is on understanding electrically conductive flowing propellants (plasmas or charged particles) that serve to convert beamed or electrical energy into kinetic form. Theoretical and experimental investigations focus on the phenomenon of energy coupling and the transfer of plasma flows in electrode and electrodeless systems under plasma dynamic environments. Initiate studies to enable revolutionary designs of satellite systems that can achieve the simultaneous objectives of increasing payload and/or time in orbit and increasing mission flexibility and scope. Research activities include fundamental component and system level research

that leads to the introduction of novel multi-use technologies and concepts, and their efficient integration at various length scales, in order to achieve multi-functional satellite architectures. It includes the development of highly efficient power generation/recovery systems (e.g. MEMS turbines, nano-structured thermoelectric units) that are deeply integrated with thermal management or spacecraft structure; Research topics include the development of novel diagnostics techniques in characterization of combustion instabilities in high pressure, harsh, optically thick environment.

Topics of interest include characteristics of pulsed and steady-state plasmas; scaling physics; characteristics of equilibrium and non-equilibrium flowing plasma; characteristics of electrical and hydrodynamic flows; instabilities of plasma bulk and wall layers; interactions of plasma-surface, plasma-electrode, plasma-magnetic, and plasma-electric fields; losses to inert parts; characteristics of plasmas in high-magnetic fields and pressures; and plasma diagnostics (new and unique non-interfering measuring techniques). Areas of research interest may include, but are not limited to: (1) design and testing of compact, highly efficient and robust chemical or electric propulsion systems with minimal power conditioning requirements; (2) demonstration of innovative uses of power and/or propulsion systems for sensing, communication, or other applications; (3) development of highly efficient power generation/recovery systems (e.g. MEMS turbines, nano-structured thermoelectric units) deeply integrated with thermal management or spacecraft structure; (4) innovative processes that transform structural material into high energy density propellant (e.g. phase change, or even biological process); (5) novel energetic materials for bi-modal propulsion; (6) development of modeling and simulation capabilities at all relevant scales.

Research is sought on chemical propulsion to predict and suppress combustion instabilities in liquid rocket systems. Topics of interest include the modeling of the coupling among unsteady flows, combustion, acoustic fields, and chemical kinetics, modeling using novel tools such as molecular dynamics, direct simulation Monte Carlo, and hybrid approach. Especially, research sought on methods to predict and suppress combustion instabilities under supercritical conditions, and develop research models that can be incorporated into the design codes, especially LES simulations.

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Metallic Materials

The objective of basic research in metallic materials is to provide the fundamental knowledge required to develop and improve metallic alloys for economically and environmentally sustainable use in aerospace applications. Applications of these materials include aircraft gas turbine engines, engines for rocket propulsion, components of airframe and spacecraft structures, armor and hypersonic vehicle systems.

This objective will be met by developing and verifying physics-based, quantitative, predictive models that relate processing, chemistry, and structure with properties

and performance of metallic materials. Representative scientific topics include the development and experimental verification of theoretical and computational models of material processing and behavior, characterization methods, processing science, phase transformations, interfacial phenomena, strengthening mechanisms, plasticity, creep, fatigue, environmental effects, and fracture. Research on improved performance for low-cost operation and maintenance of metallic structural materials is also encouraged. There is special interest in metallic materials for responsive space applications and for survivable aerospace structures. Materials included in current projects include lightweight structural metals, refractory metals, intermetallic alloys, amorphous alloys, nanoscale strengthening mechanisms, and micro/nano-laminated materials.

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Ceramic and Nonmetallic Materials

The objective of this research program is to provide scientific background for current and future Air Force-related applications of ceramics, ceramic-matrix composites (CMCs), and carbon-based composites. Of particular interest are research projects that focus on the discovery of new ceramic materials that are both lightweight and high-temperature-tolerant ($>1500^{\circ}\text{C}$) for applications in future Air Force hypersonic aircraft and space structures.

A new area of focus for this year will be in development of methodologies for the accelerated discovery of classes of materials for use in extreme environments. The recent advent of high-throughput screening techniques for multicomponent materials allows for the synthesis and screening of *tens of thousands* of samples a day. However, although combinatorial material synthesis allows large libraries to be prepared for systematic study and identification of select materials in the fields of catalysis, high strength alloys or energetic materials, the challenge remains in the identification of a *high throughput-screening tool* (i.e. fast analytical methods) for materials that are to be used at temperatures above 1600°C in oxidizing environments as well as the creation of a structure/property database that can be data mined for subsequent attributes for structural components such as creep or toughness. Therefore, proposals are encouraged in the following areas:

1. Synthesis of multi-component ultra-refractory ceramics with controlled composition and microstructure
2. Development of high throughput spectroscopic, thermal, acoustic, mechanical or chemical analysis tools to enable rapid screening of new materials
3. Development of analytical instrumentation needed to obtain in-situ measurements under extreme environments including temperatures above 1600°C , aggressive chemical environments and high acoustic loads.
4. Development of high temperature, in-situ analytical tools required for studying creep, stress/strain and crack propagation of materials under thermal or mechanical stress; characterizing micro-domains within the microstructure at elevated temperatures and prediction of high temperature failure mechanisms within multi-component ultra-refractory ceramics.

5. Development of modeling and simulation tools for predictive computational techniques that can identify optimum composition and microstructures for extreme structural capabilities, including thermal expansion, conductivity, and emissivity.

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Theoretical Chemistry

The major objective of the theoretical chemistry program is to develop new methods that can be utilized as predictive tools for designing new materials and improving processes important to the Air Force. These new methods can be applied to areas of interest to the Air Force including the structure and stability of molecular systems that can be used as advanced propellants; molecular reaction dynamics; and the structure and properties nanostructures and interfaces. Interest in advanced propellants is concentrated in the High Energy Density Matter (HEDM) Program, which aims to develop new propellant systems that can double the current payload capacity that can be put into orbit. Theoretical chemistry is used to predict promising energetic systems, to assess their stability, and to guide the efficient synthesis of selected candidates. These tools will help identify the most promising synthetic reaction pathways and predict the effects of condensed media effects on synthesis. This program is also seeking to identify novel energetic molecules and investigating the interactions that control or limit the stability of these systems. Particular interests in reaction dynamics include developing methods to seamlessly link electronic structure calculations with reaction dynamics, and using theory to describe and predict the details of ion-molecule reactions and electron-ion dissociative recombination processes relevant to ionospheric and space effects on Air Force systems. Interest in nanostructures and materials includes work on catalysis, surface-enhanced processes mediated by plasmon resonances. This program also encourages the development of new methods to stimulate and predict properties with chemical accuracy for systems having a very large number of atoms that span multiple time and length scales.

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Molecular Dynamics

The objectives of the molecular dynamics program are to understand, predict, and control the reactivity and flow of energy in molecules. This knowledge will be used in atmospheric chemistry to improve our detection and control of signatures; in high-energy-density matter research to develop new energetic materials for propellants and propulsion systems; in chemical laser research to develop new high-energy laser systems; and in many other chemical systems in which predictive capabilities and control of chemical reactivity and energy flow at a detailed molecular level will be of importance.

Areas of interest in atmospheric chemistry include the dynamics of ion-molecule reactions relevant to processes in weakly ionized plasmas, atmospheric heterogeneous chemistry in aircraft and rocket exhausts, gas-surface interactions in space, and reactive and energy transfer processes that produce and affect radiant emissions in the upper atmosphere. Research on high energy density matter for propulsion applications investigates novel concepts for storing chemical energy in low-molecular-weight systems, and the stability and sensitivity of those energetic molecular systems. The coupling of chemistry and fluid dynamics in high speed reactive flows is also of interest. Research in energy transfer and energy storage in metastable states of molecules supports our interest in new concepts for chemical lasers. Interest in understanding and controlling processes is focused on applications to propulsion and energetics.

Materials-related research includes the study of the synthesis, structure, and properties of metal-containing molecular clusters and nanostructures. Interest in nanostructures has particular emphasis on nanoscale systems in which the number of atoms or specific arrangement of atoms in a cluster has dramatic effects on its reactivity or properties. Also of interest are sensitive new diagnostic methods for detecting individual molecules and probing nanostructures. Fundamental studies aimed at developing basic understanding and predictive capabilities for chemical reactivity, bonding, and energy transfer processes are also encouraged.

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Polymer Chemistry

The goal of this research area is to gain a better understanding of the influence of chemical structures and processing conditions on the properties and behaviors of polymeric and organic materials. This understanding will lead to development of advanced polymeric materials for Air Force applications. This program's approach is to study the chemistry and physics of these materials through synthesis, processing, and characterization. This area addresses both functional properties and properties pertinent to structural applications. Materials with these properties will provide capabilities for future Air Force systems to achieving global awareness, global mobility, and space operations.

Proposals with innovative material concepts that will extend our understanding of the structure-property relationship of these materials and achieve significant property improvement over current state-of-the-art materials are sought. Current interests include photonic polymers, polymers with interesting electronic properties, liquid crystals, polymers with controlled dielectric permittivity and magnetic permeability and novel properties polymers modified with nanostructures. Applications of polymers in extreme environments, including Space operation environments, are of interests.

In the area of photonic polymers, research emphases are on materials whose refractive index can be actively controlled. These include electrooptic polymers, liquid crystals, photorefractive polymers and magneto-optical polymers. Organic

molecules with large nonlinear absorption are also of interest. Examples of electronic properties of interest include conductivity, electrochromaticism, electroluminescence, electro-pumped lasing and superconductivity. In the area of structural properties, polymers with high thermomechanical properties are desirable. End uses of these structural polymers include aircraft and rocket non-fiber reinforced composite components, canopies, coatings, and space structures. Issues relating to extreme environments, thermal, thermoxidative, radiation, atomic oxidation bombardment and extreme mechanical loading are of interests. Materials that have interesting combination of properties that can enable multifunctional applications are of interests. Nanotechnology approaches are encouraged to address all the above-mentioned issues. Approaches based on biological systems to achieve materials properties that are difficult to achieve through conventional means are of interest.

Organic based materials, including inorganic hybrids, with controlled magnetic permeability and dielectric permittivity are also of interest. Of great interest are multifunctional materials with non-trivial, low-loss permittivity and permeability at frequencies greater than 100 MHz, especially those functioning at greater than 1 GHz. This interest extends into 3-D bulk materials with negative index (both permittivity and permeability being negative).

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Polymer Matrix Composites

This program addresses materials science issues relating to the use of polymer matrix carbon fiber reinforced composites and related material technologies in aerospace and space structures such as airframes, engine components, rocket, launch vehicles and satellites. The goal is to provide the science and knowledge base that will lead to higher performance, more durable, more affordable structures for Air Force applications. The approach is to address issues relating to the development of improved performance or lower cost polymer-matrix composite (PMC) systems and the processing and the utilization of these structures during deployment. Examples of these include resin chemistry and formulations, prepregs processing, dry preforms, lay-up operation, various injection molding techniques and cure processes. Mechanical behaviors and composite mechanics issues will also be included.

Innovative material concepts that will lead to higher temperature and more damage-tolerant composites, lower cost processing and fabrication, and improved materials for space operations and launch vehicles are sought.

Current research interests include high performance resin systems that can show substantial improvement over current chemistry utilized in aerospace systems. Nanocomposite concepts that are relevant to improving or replacing current carbon fiber reinforced composites or incorporating multifunctionalities in the laminate structures are of interest. The research targets in this area can address the matrix resin, fiber, ply or laminate level.

Research that can improve the use of computational methods in accelerating new materials development and component design of polymer matrix composites is encouraged. Mechanical models that can predict matrix sensitive laminate properties are encouraged. Models that enable reliable prediction of mechanical, thermal, or thermoxidative behavior of composites with 3D complex hybrid reinforcement architecture and the design of these structures to meet requirements of extreme environments are also of interests.

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Surface and Interfacial Science

The objective of the Surface and Interfacial Science program is to improve the fundamental understanding of the structure and reactivity of surfaces and how they interact with their environment at the interface. This work will lead to a better understanding of the mechanisms involved in surface processes, and it will provide the foundation for the development of advanced surface structures and interfaces for future Air Force applications.

The research funded under this program falls into three broad categories: surface chemistry, tribology, and electrochemistry. This research investigates basic chemical phenomena at the interface, fundamental mechanisms of friction and wear, corrosion and materials degradation, electrochemical energy storage, and electrochemically induced reaction products and kinetics. The surface chemistry program includes efforts that are studying the mechanisms of corrosion of aluminum alloys and prevention of that corrosion as well as surfaces with tunable properties. Work supported by this program also includes chemical sensing of corrosion and wastes at the interfaces/surfaces of aircraft and their servicing environment. This may lead to development of new diagnostic tools that will alert technicians to areas of an aircraft that are experiencing corrosion, or it may provide new sensors that will help detect and monitor toxic materials and substances in the aircraft environment. The tribology program includes research that investigates the fundamental properties of friction and wear in extreme environments (both hot and cold and under vacuum) and also at the nanoscale. Of particular interest are projects that can link micro or nano scale frictional properties to what we already know at the macro scale.

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Physics and Electronics (NE)

Research in physics and electronics generates the fundamental knowledge needed to advance Air Force operational capabilities in directed energy weapons; surveillance; electronic countermeasures; guidance and control; information and signal processing; and communications, command, and control. The program is of substantial breadth, extending from plasma and quantum physics, to the understanding of the performance of novel electronic devices, to maintaining

device integrity in the harsh environment of space. The program includes theoretical and experimental physics from all disciplines, as well as engineering issues such as those found in microwave or photonic systems or materials-processing techniques. One main objective of the program is to balance innovative science and Air Force relevance, the first element being forward looking and the second being dependent on the current state of the art. This directorate takes particular pride in the strong synergistic ties it has forged between university researchers and those in the Air Force Research Laboratory community. Research areas of interest to the Air Force program managers are described in detail in the sub areas below.

Electro Energetic Physics

This Air Force program seeks innovative approaches and novel concepts that efficiently drive or cleverly exploit the collective interactions of charged particles with electromagnetic fields or the effects of resultant plasmas on their surroundings. Our primary interests currently encompass ideas for advancing the state-of-the-art in the following areas: electron-beam-driven sources of microwave and millimeter-wave radiation (high power microwaves (HPM) and/or vacuum electronics), compact pulsed power, particle-beam physics, next-generation combat simulation, power-efficient methods to generate and maintain significant free-electron densities in sea-level air, as well as particle-beam-related micro-and/or nano-device concepts. New concepts for the detailed modeling and simulation of the above physical phenomena are also of interest.

Research in the e-beam-generated microwave source area will address Air Force needs for communications, surveillance, electronics countermeasures, and/or directed energy weapons systems.

Of particular interest, would be new ideas for micro-scale or nano-scale plasma and/or vacuum electronics device concepts. This does not include field-emitter area (FEA) research. Specifically, MEMS concepts that could be applied to a sensor/actuator system for a future “smart” microwave tube would be exceptionally interesting.

Of course, fresh ideas for completely new plasma-, vacuum-electronics or pulsed-power-related research areas are always of interest as long as Air Force relevance can be postulated.

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Atomic and Molecular Physics

This program involves experimental and theoretical research on the properties and interactions of atoms and molecules. Atomic and molecular interactions with electromagnetic radiation and gravitational fields form the basic underpinning of a large range of technical applications addressing current and future Air Force needs. These include timekeeping, navigational guidance, remote sensing, secure communications, and atmospheric physics. Traditional Air Force efforts also

include research in low- and high-altitude nuclear weapons effects, directed energy weaponry, and lasing mechanisms.

Specific research topics of interest include:

- Studies of the overlap between atomic and condensed matter physics – particularly the usage of atomic physics to learn about many-body phenomena
- Ultra-cold atoms in optical lattices
- The evolution of cold atomic systems into ultralow-density condensed matter systems
- Studies of ultracold atoms in optical lattices
- The interaction of atoms and molecules with strong fields
- Cooling and trapping techniques applied to a broad range of problems, including high-resolution spectroscopy and cold atom collisions—particularly between atoms in excited quantum states.
- High-precision techniques for navigation, guidance, and remote sensing—particularly those suited for usage in an orbital environment.
- The formation and evolution of cold (<1 K) plasmas.
- Antiproton capture, confinement, transport, injection, and annihilation processes— particularly those leading to the formation and storage of anti-hydrogen.
- Novel techniques for production of high-power microwaves, X-rays, and gamma rays.
- Cross-sections of atmospheric species.

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Physical Mathematics and Applied Analysis

This program conducts research in physical mathematics and applied analysis to develop accurate models of physical phenomena to enhance the fidelity of simulation. It investigates the properties of coherently propagating ultrashort laser pulses through the air and their exploitation in areas such as electronic warfare (ancillary production of HPM) and laser-guided munitions (possible propagation through obscurants). It develops algorithms to simulate nonlinear optical effects within solid state lasers (with weaponization and communication in mind) and nonlinear optical media. The program supports studies in the feasibility of designing reconfigurable warheads by suitable placement/timing of microdetonators as well as the prediction of the combustion of solid rocket propellant. The program pursues descriptions of the dynamics of internal stores released from transonic or supersonic platforms as well as the enhancement of platform agility through the exploitation of plasmas. Also, it pursues the dynamics of the atmosphere near and above the tropopause with an emphasis on the understanding of atmospheric gravity wave propagation as well as turbulence and their production by topography and storms is of interest. Other areas of interest include the understanding of chaos in circuitry such as missile guidance systems, prediction of effective properties of various composite media, advanced fracture

mechanics theories (which also include thermal loading such as might be produced by exposure to a strong laser).

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Electromagnetics

Conduct research in electromagnetics to produce conceptual descriptions of electromagnetic properties of novel materials/composites (such as photonic band gap media or negative index media) and simulate their uses in various operational settings. Evaluate methods to recognize (the inverse scattering problem) and track targets (including Improvised Explosive Devices) and to penetrate tree covers, clouds, the ionosphere or other dispersive/random/turbulent media with wide band radar (propagation of precursors for example) and design transmitters to produce such pulses. Develop computational electromagnetic simulation codes that are rapid and accompanied by rigorous error estimates/controls.

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Laser and Optical Physics

Laser and optical physics research explores new ideas, knowledge, and insights in selected aspects and applications of these areas. Novel lasers and laser arrays, as well as nonlinear optical devices and phenomena are of interest. Application studies of microstructured optical fibers are ongoing and would be considered for expansion if funds are available. High brightness, narrow spectrum incoherent sources and arrays are also of interest directly for applications as well as for laser pumping. Ultrafast lasers and their applications are of interest, particularly small, lightweight, inexpensive, and high repetition rate sources, and their applications. Semiconductor laser arrays are being investigated, together with associated optics, in the mid-infrared, in support of ongoing important Air Force development programs. Directed energy beams, particularly laser beams, are being explored in novel direct-write materials-processing techniques that offer broad and extremely important new capabilities, particularly in micro-devices and micro-systems fabrication and packaging, particularly for space. Novel sources of monochromatic x-rays will be considered, particularly relatively small ones.

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Remote Sensing and Imaging Physics

This program investigates fundamental issues concerning remote sensing and the physics of imaging, including image formation processes, propagation of electromagnetic radiation through the environment and interacting with matter, target detection and identification, and the interaction of Air Force imaging

systems and sensors with the space environment. Technological advances and miniaturization of spacecraft are driving the requirement for innovative methods to detect and identify space objects. Optoelectronic circuitry and memory will facilitate the storage and transmission of data sets that are orders of magnitude larger than current system capabilities and will require high speed and error free communication links through the intervening medium. Proposals are sought in all areas of ground, air, and space-based remote sensing and imaging, but more particularly in the detection and identification of space objects. Research goals include, but are not limited to:

1. Innovative methods of remote target location and identification, including non-imaging methods of target identification.
2. Ground based identification of space objects that are too small or too distant to image, including changes in conditions that affect target identification, such as environmental changes and surface aging or weathering.
3. Remote sensing signatures and backgrounds, particularly sensing from space and observations of space objects from the ground, and the sensing of difficult targets such as targets under foliage, buried targets, etc.
4. Enhancement of remote sensing capabilities, including novel solutions to system limitations such as limited aperture size, imperfections in the optics, and irregularities in the optical path.
5. Theoretical foundations of remote sensing and imaging.
6. Rigorous theory and models to describe the spectral and polarimetric signature from targets of interest using basic material physical properties with the goal of providing better understanding of the physics of the reflection or emission and the instrumentation requirements for next generation space surveillance systems.
7. Propagation of coherent and incoherent electromagnetic energy through a turbulent atmosphere, including laser propagation for energy transport, imaging, and communication.
8. The interaction of Air Force imaging systems and sensors with the space environment.

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Space Sciences

The AFOSR Space Sciences program seeks basic knowledge of the space environment to apply to the design and calibration of Air Force systems operating in and through space. For AFOSR purposes, the space environment begins at the base of the Earth's ionosphere, at an altitude of approximately 80 km (50 miles). Both the nominal and disturbed space environment can disrupt the detection and tracking of aircraft, missiles, satellites, and other targets, distort communications and navigation, and interfere with global command, control, and surveillance operations. The physical and chemical behavior of the Earth's upper atmosphere affects the performance and longevity of Air Force systems operating in low-Earth orbit. Among other themes, AFOSR will consider research proposals related to:

- Ionospheric plasma turbulence and dynamics;

- Observing and modeling neutral winds, atmospheric tides, and gravity waves in the ionosphere;
- Variations in solar radiation received at Earth and their effects on satellite drag; Geomagnetic disturbances and their impacts on the ionosphere; Electron density structure and ionospheric scintillation; and Auroral and airglow evolution, as well as their spectroscopic emission signatures.

This program's goals are to improve the global specification and forecasting of the evolution of ionospheric irregularities and scintillation, to improve the specification of thermospheric dynamics and neutral densities, and to validate and enhance current ionospheric models using data assimilation techniques to improve operational forecasting and specification capability. In the space environment well above low-Earth orbit, at geosynchronous orbit and beyond, phenomena such as solar eruptive events, variable interplanetary magnetic fields, solarelectromagnetic radiation, natural space debris, cosmic rays, geomagnetic storm enhancement of Earth's radiation belts, and interplanetary dust can degrade Air Force spacecraft and systems. In this regime, research interests include, but are not limited to:

- The physics and chemistry of meteoroids, interplanetary dust, asteroids, and comets;
- The structure and dynamics of the solar interior and their role in driving solar eruptive activity;
- The mechanism(s) heating the solar corona and accelerating it outward as the solar wind;
- The triggers of coronal mass ejections (CMEs), solar energetic particles (SEPs), and solar flares;
- The coupling between the solar wind, the magnetosphere, and the ionosphere;
- The origin and energization of magnetospheric plasma; and
- The triggering and temporal evolution of geomagnetic storms.

The ultimate AFOSR goal is to develop a predictive, global, coupled solar-terrestrial model that connects solar activity and output with the deposition of energy in the Earth's upper atmosphere, by specifying the flow of mass, momentum, and energy through interplanetary space, and by forecasting the turbulent plasma phenomena that mediate this flow. The AFOSR Space Sciences program is also involved in advancing deep space surveillance techniques to observe and track Near Earth Objects and other physical threats to Air Force systems. In this regard, innovative astronomical detection and observation methods that involve advanced technology are also needed. Astrophysical or astronomical research and observations that investigate stellar-planetary interactions in general and physical processes occurring in the Sun in particular, are also of interest.

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Quantum Electronic Solids

This program focuses on materials that exhibit cooperative quantum electronic behavior, with the primary emphasis on superconductors, and on any conducting materials with surfaces that can be modified and observed through the use of scanning tunneling and related atomic-force microscopic techniques, the ultimate goal being the creation of new nano-devices and structures. The program also focuses on device concepts using these materials for dense non-volatile memory elements, electromagnetic detection and signal processing in Air Force systems. The long-standing materials aspects of this program are based on the fabrication, characterization, and electronic behavior of thin and thick superconducting films that ultimately can lead to the production of new and improved electronic circuit elements and high-current-carrying cables. The major focus of the program is on coated conductors to be used in producing tapes that will be formed into cables in electromagnets and power applications. Secondary objectives are to understand the mechanisms that give rise to superconductivity in selected ceramics and to produce high-quality Josephson tunneling structures. A continuing interest in this program is the search for new electronic device concepts that involve superconductive elements, either alone or in concert with semiconductors and normal metals. New fabrication techniques for the generation of LSI of ceramic Josephson junctions are likewise of interest. Discovery of practical higher-temperature superconducting materials remains an important goal.

A growing aspect of this program is the inclusion of scanning probe and other techniques to fabricate, characterize, and manipulate atomic-, molecular-, and nanometer-scale structures (including carbon and other elemental nanotubes), with the aim of producing a new generation of improved sensors and non-volatile, ultra-dense memory, resulting in the ultimate miniaturization of analog and digital circuitry. This program element includes the use of polarized electrons to produce nuclear magnetic polarization as a basis for dense, non-volatile memory, with possible application to quantum computing at room temperature.

An increasingly important addition to this program features the investigation of so-called "left-handed materials" (also characterized as negative-index materials) and how to utilize them to produce compact and efficient circuit elements for aerospace communications and surveillance systems both at microwave frequencies and in the visible, IR and terahertz regions of the electromagnetic spectrum.

Finally, there is a continuing interest in the development of new (soft and hard) magnetic materials with high energy products at elevated temperatures to aid in providing power devices, switches and bearings for a new generation of more-electric aircraft that dispenses with hydraulics.

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Electronic and Detector Material Structures and Device Concepts

This basic research program seeks to investigate and exploit novel solid-state electronic and detector material systems, structures, and device concepts and implementation schemes vital to support future U.S. Air Force system capability needs for ultra high-fidelity remote sensing, high-speed data processing, and wideband communications. Emphasis is on high-risk-high-payoff research essential for future warfighter system capability breakthroughs in performance, functionality, reliability, and survivability. The current program is organized into two thrusts:

EO & RF Signal Detection Concepts: Air Force warfighters require improved remote sensing capabilities to provide increased fidelity target discrimination at greater standoff ranges for confident difficult target ID (e.g. people, vehicles; friend or foe). Advancements in remote sensing technology are needed to ensure near real-time full battle space awareness. For example, while today high/medium-altitude aircraft provide high fidelity ground target discrimination, they provide only narrow fields-of-view; space-based sensing provides much broader area coverage, but with limited target resolution. Hence, ongoing research is focused on novel sensor system concepts and techniques aimed at substantially improving target detection sensitivity, resolution, speed, and stand-off range. Target detection spectrum of interest spans RF to UV. Sensing approaches of interest include, but are not limited to, novel EO and RF techniques for spatial, spectral, radiometric, temporal, polarimetric, and other imaging and non-imaging detection and discrimination; agile, reconfigurable, tunable, pixel/detection elements capable of autonomously adapting to changing target scenarios; novel concepts for same-pixel multicolor architectures (>3 bands), including innovative pixel-to-read-out IC interconnect schemes; multifunctional detection concepts exploiting multiple target observables (e.g., RF & IR) within the same detector element; non-classical absorber material-optical interaction effects for novel discrimination; novel concepts for 3-D (x , y , λ) focal plane array detection; structures that integrate cooling and/or avoid heating; and biologically inspired detection processes and concepts. Possible detector structures include, but are not limited to, monolithic and hybrid homo- and hetero-structures, quantum and nano devices, and any combination there of, with the caveat that device concepts should have a reasonable expectation for yielding external quantum efficiencies in excess of 70%.

High-Speed, Robust, Reconfigurable, and Multifunctional Electronics Concepts: This thrust includes fundamental research in novel electronic material systems, advance processing and fabrication sciences, advanced physical modeling & simulation capabilities, and micro, nano, and quantum electronic structures and devices. Emphasis is on insertion of these technologies into ultra high-speed computing and information, signal, & image processing architectures, ultra high-density non-volatile memories, and high power mm-wave RF electronics for wideband radar & communications. Research is focused on breakthroughs in electronic device performance, functionality, reliability, and survivability, while simultaneously reducing component power, mass and size. Of special interest are novel structures & device concepts based on programmable 'reconfigurable' materials whose physical properties may be dynamically tailored via multiple

applied 'stimuli' (e.g., E and B fields, mechanical stress, heat, etc.) in response to changing device, circuit, or system requirements, such as that driven by radiation induced degradation or changing mission requirements. Additional research interests include quantum confined structures; novel nano-scale device interconnect schemes; innovative 3-D IC concepts, including thermal control schemes; and novel heterogeneous material system structures and devices.

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Sensor and Detector Materials

This research area is directed toward developing advanced optoelectronic, magnetic and electronic materials and structures to provide improvements required for future Air Force systems. The focus is currently on growth and use of semiconductors, magnetic alloys, and specialized dielectrics in bulk structures, heterostructures, quantum wells, superlattices, quantum wires, and quantum dots. Proposals are sought for significant advances in these areas, or expansion to novel application of materials with estimates comparing potential improvements to present capabilities and the impact on Air Force capabilities. Wavelength ranges of interest span the spectrum from UV, visible, NIR, MWIR, FIR, and extending into the terahertz range. Multifunctional materials which combine optical, electronic, ferromagnetic and/or piezoelectric properties are also of great interest.

Novel fabrication methods, in-situ and ex-situ characterization methods, and innovative substrates and materials that increase the integration density, or fill factor and efficiency are of significant interest, as are device structures that integrate cooling, or exploit designs that avoid heating. Nonlinear optics is another area of interest for increasing laser power at desired wavelengths, and protection from directed energy threats. Advanced optoelectronic and electronic materials will provide the building blocks for advances in laser and sensor applications and related components.

Compound semiconductors, heterostructures and other such materials are the foundation of new generations of wavelength-diverse, high sensitivity detectors, and lower power consumption, high-efficiency electric lasers, as well as high efficiency multifunction solar cells and related multi-level functional devices and concepts. Prospective ferromagnetic semiconductor systems can open new windows on sensor and device development. A functional understanding of properties of spintronic material is crucial for subsequent device development. All of these materials provide the properties necessary for improved space situational awareness, National and Theatre Missile Defense (NMD/TMD) capabilities, and space asset protection to support Space Control, and theater missile surveillance, threat warning and tracking, chemical and biological agent detection, improved satellite communications, and environmental monitoring as part of Space Force Enhancement. These specialized sensor and detector materials provide the basis for new devices and significantly improved performance and capabilities for systems that are needed to provide survivability to aircrews, sensor systems, aircraft, and space systems from directed energy threats.

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Optoelectronics: Components and Information Processing

The current primary program thrusts include investigations in two affiliated areas: (1) the development of optoelectronic devices and supportive materials, and (2) the insertion of these components into optoelectronic computational and information-processing systems. Device exploration and architectural development for processors are coordinated; synergistic interaction of these areas is expected, both in structuring architectural designs to reflect advancing device capabilities and in focusing device enhancements according to system needs.

Research in optical materials and optoelectronic devices emphasizes the insertion of optical technologies into computing, image-processing, and signal-processing systems. To this end, this program continues to foster surface-normal interconnection capabilities, combining arrays of sources or modulators with arrays of detectors, with both being coupled to local electronic processors, often in "smart pixel" configurations. Understanding the fundamental limits of the interaction of light with matter is important for achieving these device characteristics. Semiconductor materials and structures are the basis for the smart pixel and related device technologies. Numerous device approaches are part of the program as are techniques for optoelectronic integration.

System-level investigations incorporate these devices into processing architectures that exploit their demonstrated and envisioned attributes and determine appropriate problem classes for optical and optoelectronic approaches. The computational advantages and proper use of parallelism provided by optical implementations continue to guide architecture development. Computer interconnections continue to encounter increasing difficulty in signal transmission constrained by wire-crossing layout restrictions, electromagnetic interference, and cross-talk--impediments that may be circumvented by optical interconnect approaches. Alternatively, another program thrust emphasizes the use of the inherent, extremely high bandwidth of optical carriers by investigating systems that use multispectral data representations.

Fabrication of optical structures has now evolved to a precision, which allows us to control light within etched nanostructures. As semiconductor fabrication has matured so too has the crystal growth of quantum "boxes" for localizing electronic states in semiconductors. The combined engineering of electronic and optical "cavities" on the nanometer scale in semiconductors opens up several fruitful paths for advancing current and future technologies. The program is interested in the design, growth and fabrication of nanostructures that can serve as building blocks for nano-optical systems. The research goals include integration of nanocavity lasers, filters, waveguides, and diffractive optics, which can form nanofabricated photonic integrated circuits. Coupled to this area are optoelectronic solutions to enable practical quantum computing schemes.

In bridging the gap between electronics and photonics the program also explores opportunities in terahertz technologies. Diverse approaches have been taken to create THz sources and detectors over the 0.3 to 10 THz range. Desired are THz sources and detectors that are compact, efficient, solid-state devices capable of integration with other solid-state components. Integration of transmit and receive functions on the same chip is another goal. More specifically quantum well solutions are of highest interest.

This program supports Air Force requirements for information dominance by increasing capabilities in image capture; processing, storage, and transmission for surveillance; target discrimination; and autonomous navigation. In addition, high-bandwidth interconnects enhance performance of distributed processor computations that provide real-time simulation, visualization, and battle management environments.

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High Density Optical Memory

There is a growing need within the Air Force for more and better computer data storage to support next generation processor architectures and new multi-media application software. This program thrust explores optical memory technologies that support page-oriented or holographic configurations in two or three dimensions. Capabilities of persistent spectral hole-burning systems for memory as well as for processing anchor this thrust. The spatio-spectral attributes of this technology link "free-space" interconnect concepts to those of multispectral systems. Devices are being developed that emit, modulate, transmit, filter, switch, and detect multispectral signals, for both parallel interconnects and quasi-serial transmission. It is important to develop the capability to buffer, store, and retrieve data at the rates and in the quantity anticipated by these devices.

Atomic and molecular absorption of light within semiconductor and optoelectronic materials is the basis for the technologies in the homogeneously broadened, generally cryogenic, optically resonant materials that support the memory development. Understanding the fundamental interaction of light with matter is important for achieving these characteristics. Architectural problems are also of interest that include, but are not limited to, optical access and storage in memory devices to obviate capacity, access latency, and input/output bandwidth concerns.

This program supports Air Force requirements for information dominance by increasing capabilities in image capture; storage, and processing for surveillance; target discrimination; and autonomous navigation. Further important considerations for this program are the airborne and space environment in which there is a need to record, read, and change digital data at extremely high speeds.

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Mathematics, Information and Life Sciences (ND)

The Directorate is responsible for research activities in mathematics, information and life sciences. A wide range of fundamental mathematical, information and computer sciences, biology, and behavioral research is supported to provide the Air Force with novel options to increase performance and operational flexibility. Although the program descriptions that follow are specific sub areas of interest, there is interest in exploring novel ideas that bridge the disciplines. Many critical research activities are multidisciplinary and involve support from the other scientific directorates within AFOSR. The interfaces between disciplines often provide the insights necessary for technological advances. Creativity is encouraged in suggesting novel scientific approaches for our consideration.

Biophysical Mechanisms

The primary objective of the biophysical mechanisms program is to discover and understand basic biological mechanisms that could be used to either harden or repair bio-based devices or can utilize complex, impure biofuels for compact power. This will enable the Air Force to employ biologically based systems, either within or outside of a living cell, with optimum performance and extended lifetimes. As biological molecules are increasingly used as catalysts, sensors and as biomaterials, it will be necessary to understand how we can utilize these molecules in extreme environments, with the ability to regulate the desired function as conditions change and to store the device for prolonged periods of time.

Areas of interest include: the mechanisms for survival and protein stability in extremophilic archaea, fundamental studies of bacterial sporulation, biological mechanical energy storage, novel bioelectrode designs, electron and proton transfer reactions and kinetics between enzymes/microbes and the electrode surface, theoretical modeling of mass transport in model biofuel cells, and enzyme engineering for faster catalysis.

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Chronobiology

This program supports research that provides a foundation for the development of effective measures to counter human fatigue, specifically fatigue induced by sustained wakefulness or by chronic sleep deprivation. Both circumstances are of concern to the Air Force because of requirements for sustained operations or for shift work that is out of phase with natural biological rhythms (e.g. night operations).

Current efforts investigate the interaction of circadian and homeostatic systems in the regulation of cognitive and psychomotor performance. Human neurobehavioral data is used to develop and refine mathematical models of the

circadian/homeostatic interaction. A comprehensive effort is underway to measure and integrate the various effects of behavioral routines, sleep scheduling, exposure to light and wake-promoting pharmaceuticals.

The chronobiology program has very limited funding available for new projects. Preference is given to proposals that can contribute directly to new countermeasure developments or that open novel avenues for such developments. General investigations of circadian physiology, especially in areas supported by other federal agencies, are unlikely to be accommodated. New approaches that promise breakthroughs in understanding the cognitive and psychomotor consequences of sleep deprivation will be considered.

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Biomimetics, Biomaterials, and Biointerfacial Sciences

The goals of this biology, chemistry, and physics program are to study, use, mimic, or alter how biological systems accomplish a desired (from our point of view) task or to enable them to do a specific task in order to produce biomaterials and systems, which will enable future US Air Force technologies. This program not only wants to mimic existing biological systems, but also to create new capabilities in these organisms for more precise control over system production. The research will encompass three general areas: biomimetics, biomaterials, and biointerfacial sciences.

Biomimetic research is for enabling the development of novel sensors, engineering processes, and mechanisms. It will study the fundamental principles, processes, and designs of infrared sensitive biosystems at the sub-cellular, molecular and genomic levels to enable the further development of infrared materials, devices, and systems with enhanced structural and functional capabilities. Included are identify, model, and construct alternative biomimetic, near ambient infrared sensing devices. Finally, this program wants to probe and manipulate the functionality of alternative sensors for time-response characteristics, and adapts biochromophores and biophotoluminescent characteristics in microbial and protein-based biosystems for applications to military sensor systems.

The biomaterials area is focused on synthesis, structure, and properties of novel materials and nanostructures. Specifically, it will address either the mimicking of natural materials, using organisms as biomaterial factories of new materials, genetically altering existing organisms for new materials capabilities, or taking existing biomaterials/organisms and using them as novel materials like viral gradients or processing them further to make useful material as in biomineralization.

The biointerfacial sciences area is focused on new biosensors and bionanotechnology. Specifically, it will address the fundamental science at either the biotic-biotic or the biotic-abiotic interface. This will include both sensor arrays using combinatorial methods, and the transduction of the desired event for display and processing. It includes most of the non-electromagnetic biosensor work as

well as surface structure efforts down to the nanoscale for addressing bionanotechnology and biomesotechnology efforts.

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Cognition and Decision

This program supports research on high-order cognitive processes that are responsible for human performance on complex problem solving and decision making tasks. The overall objective is to understand these processes by developing and empirically testing mathematical or computational models of motivation, attention, memory, learning, problem solving, and decision making. We are especially interested in the interactions among these processes. Specific objectives include, but are not limited to, the development of quantitative models and methods that improve our understanding of (1) integration or fusion of multi-dimensional information, (2) influence of attention and memory on complex task performance, (3) learning processes in the acquisition of complex problem solving skills, (4) individual decision making in dynamic tasks, (5) inference and reasoning under uncertainty, and (6) team, group, and distributed decision-making. Of particular interest are the development and empirical testing of models of individual and team behavior that can explain deviations between optimal and human performance for tasks such as detection, recognition, categorization, prediction, inference, information search, integration, decision making, task scheduling, resource allocation, and team coordination. The study of these topics in conditions that involve uncertainty, changing environmental conditions, high workloads, sustained operations, stress, or fatigue is encouraged. Multidisciplinary approaches are also encouraged, especially if useful in the development of quantitative or computational models of these human performance issues.

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Sensory Systems

The sensory systems program pursues an understanding of biological sensing mechanisms and investigates the integration of multiple sensory systems in human perception. Emphasis is on studies that can contribute the basic science foundation needed to inform new approaches to enhance human performance. This program supports research that coordinates empirical studies with mathematical or computational modeling. The development of theoretical models is desired, in part, for their eventual application to human factors problems, such as those that arise in the design of human systems to, for example, assist spatial orientation or navigation, find, track, and manipulate objects, or respond to acoustic information from multiple, simultaneous sources.

The current emphasis of this program is on the dynamic integration of multiple sensory inputs in human performance. One ongoing effort deals with the integration of auditory, visual, vestibular, and somatosensory inputs in response to

non-standard gravito-inertial forces. Another effort deals with the coordination of head and eyes in tracking moving targets. A third effort studies several aspects of spatial audition, including sound localization, distance perception, and auditory cueing of visual search. The program is multi-disciplinary, drawing upon expertise in areas such as neurophysiology, computer and electrical engineering, biology, mathematics, and experimental psychology. Applicants are encouraged to develop collaborative relationships with scientists in the Air Force Research Laboratory.

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Biological Response Profiling and Assessment

The characterization, understanding and accurate prediction of biological responses elicited by various chemical and physical agents underscore much of the research supported by this program. The knowledge base that is generated as a product of this research will ultimately be used to (1) insure hazard-free development of advanced technologies, (2) help provide science-based standards for the safe operation of novel weapon systems and (3) enable the innovation of biotechnologies that enhance both the performance and protection of military personnel during deployment. The type of agent and the dose and duration of its biological interactions are paramount in determining whether a biological effect is negative (toxic/inhibitory), neutral (biocompatible/benign) or positive (beneficial/stimulatory) in nature. Basic research is supported that explores interactions of agents with biological systems at the cellular and molecular levels. Important areas include differentiating biological responses elicited by agents at high (test) and low (ambient) exposures, examining the fundamental nature of these dose-response relationships (linear, non-linear and threshold), and identifying early molecular triggering mechanisms involved in the responses. The use of transcriptomics, proteomics, and/or metabolomics to profile and assess the biomolecular responses of cells is encouraged. Interpreting the data for mechanistic understanding and distinguishing between adverse, benign and potentially beneficial effects is especially challenging. Studies are supported that effectively combine novel experimental approaches and computational techniques for the purpose of predicting toxicity or for developing biokinetic models of complex mixtures. Recent research, for example, has focused on elucidating the biodynamic mechanisms of jet fuel-induced toxicity as well as developing a biokinetic model of jet fuel exposure for use in health risk assessments. Because many novel chemicals, nanomaterials and modes of radiant energies (microwaves, radio frequency radiation and ultrashort laser pulses) are continually being developed for future use, improved (i.e., reliable, rapid and inexpensive) methods are needed for estimating health risks. Mechanistically based *in vitro* biomarkers combined with computational toxicology/chemistry represent research areas that may contribute to such methods advancements.

The current program also supports research seeking to explain how certain oxygenic phototrophs, such as microalgae and cyanobacteria, use light energy to generate molecular hydrogen from water. Knowledge of the physiological, biochemical and genetic factors involved in limiting this light-induced biohydrogen response will be used to bioengineer an organism whose generation of hydrogen

will be both highly efficient and capable of exquisite control. Basic research in photosynthetic biochemistry and hydrogenase enzymology is viewed as essential to accomplishing these objectives and, eventually, to developing the biotechnological strategies needed for the renewable production of carbon dioxide-neutral hydrogen fuel from sunlight.

The following summarize the basic research interests of the Air Force in Biological Response Profiling and Assessment:

I. Biological Responses to Chemicals and Nanomaterials

- A. Cellular/molecular mechanisms and biomarkers of effect
- B. Low-dose, nonlinear biological response relationships
- C. Biomolecular response profiling
- D. Structure-activity relationships from a quantitative, computational and predictive perspective
- E. Modeling: biokinetics (physiologically based pharmacokinetics) of complex mixtures and biodynamic response modeling of chemicals and nanomaterials

II. Biological Responses to Non-Ionizing Radiation

- A. Acute and chronic low intensity interactions of sub-nanosecond laser pulses with ocular and dermal tissues
- B. Interactions of ultra-wide band and high-peak power radio frequency radiation and microwaves with cells/tissues
- C. Biomolecular response profiling
- D. Biophysical and mathematical modeling of radiation-induced responses
- E. Biomarkers of exposure and effect
- F. Photosystems, hydrogenases and water-based bio-solar hydrogen generation

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Dynamics and Control

This program is devoted to basic research in dynamics and control, leading to improved techniques for the design and analysis of control systems with enhanced capabilities and performance for insertion into future Air Force systems. Proposals should include connectivity to appropriate Air Force air, space, and information system applications, which currently include advanced high-performance aircraft, unmanned aerial vehicles, missile systems, precision munitions, satellites, spacecraft, and command and control systems.

The Dynamics and Control program is interested in robust and adaptive feedback control concepts including: adaptive, reconfigurable flight control systems; guidance, navigation, and control of autonomous aerial vehicle systems and teams; image tracking and robust feedback control in high scintillation environments; control for rapid and precision targeting; active control of

electromagnetic radiation by mastering the properties of a propagating surface; control and optimal design issues in aeroengines; control of fluid flow processes associated with aero vehicles; control using advanced airborne and space-borne sensors and actuators; and novel hybrid control systems that can intelligently manage actuator, sensor, and processor communications in complex, spatially distributed systems. The program emphasizes research in robust and adaptive multivariable feedback control applicable to nonlinear systems; constrained and receding horizon optimal control; novel approaches to system identification; integrated control and multidisciplinary design optimization; control of complex coupled fluid-structure systems; control allocation for distributed actuators; and, to a lesser degree, fundamental applied research in stochastic control, and control of discrete event dynamical systems. In general, support for research in linear systems theory is decreasing, while interest in control of complex, multi-scale, highly uncertain nonlinear systems is increasing.

Increased interest exists in the development of control concepts applicable to single and multiple unmanned aerial vehicles (UAVs) and micro air vehicles (MAVs). Areas of interest include cooperative/collaborative control of a team of UAVs conducting operations such as cooperative combat ISR, electronic attack, urban warfare, wide area search/attack, and persistent area denial. Real-time, adaptive acquisition, classification, prosecution and assessment of geographically dispersed targets are envisioned, requiring cooperation amongst UAVs such that critical timing constraints are satisfied for optimal performance. A cooperative decision and control theoretic framework is of interest to address robust dynamic control of distributed UAVs executing multiple, strongly coupled tasks with a high degree of decentralization. Areas of interest for MAVs include control issues associated with microscale vehicles including control schemes in a sensor rich environment, novel actuation processes and allocation, low order modeling, and gust alleviation.

A long-term goal of the Dynamics and Control program is control for intelligent autonomy, in order to achieve a higher level of autonomous control. The main features of autonomous control systems are determined by the need to solve complex optimization problems in the presence of uncertainty, in near real-time and without human intervention. Providing UAVs and MAVs with faculties of wide field-of-regard perception will be a significant step toward the realization of autonomous control, and in this area research in vision-based guidance, navigation and control is of interest.

The dramatic increase in complexity of Air Force systems provides unique challenges for the Dynamics and Control program. Meeting these challenges will require interdisciplinary approaches to provide significant advances in methods and tools for modeling, simulation, analysis, and real-time control of multi-scale, hybrid dynamical systems. In this regard, concepts motivated from studies of biological organisms and processes are of interest.

The Dynamics and Control program places special emphasis on techniques addressing realistic treatment of physical applications, to include attention to constraints, scalability, and complexity management, handling of system variations and environmental uncertainty, and real-time operation in extreme and adversarial environments.

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Computational Mathematics

This program aims to develop improved mathematical methods and algorithms that exploit advanced computational capabilities in support of Air Force scientific computing interests. For the most part, this program seeks to develop innovative methods and algorithms that improve modeling and simulation capabilities. These improved capabilities, in turn, enable understanding, prediction, and control of complex physical phenomena crucial to the Air Force. These phenomena include fluid mechanics, plasma dynamics, combustion processes, structural dynamics, processing and performance of composite and tailored materials and crystal growth. Research in the computational mathematics program enables technological advances in aerodynamics, airbreathing propulsion, space propulsion, high-power microwaves, micro and nano devices, material design and structural mechanics. Research also supports the national program in high performance computing.

This program is developing numerical methods and algorithms to fully exploit the potential of high performance computers in calculating fast, accurate numerical solutions of complex systems occurring in both the design and operation of Air Force systems. Efficient use of available parallel machines requires that we pay increased attention to dynamic resource allocation and load balancing, domain decomposition techniques, scalable parallel algorithms, adaptive meshing, and parallel schemes for adaptive grid generation. As the cost of hardware continues to decrease, the results of this program may affect the design of specialized architectures for solving critical scientific problems.

Typically, the computational models in this program rely on some numerical scheme that implements a discretization of continuum mechanics equations--generally partial differential equations--that represent the physics of the particular problem. However, alternative computational models may be appropriate for some problems. To characterize the behavior of large, complex, real-world systems, we are examining numerical algorithms which include multi-scale and multi-physics approaches. Additionally, developing rigorous algorithms for efficient and robust multidisciplinary design and optimization and computing with uncertainty is of interest. This program develops and improves a variety of numerical methods in these areas, including finite difference methods, finite element methods, spectral methods, lattice gas algorithms, particle and vortex methods, essentially nonoscillatory methods and hybrid methods.

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Distributed Intelligence

Military plans and operations benefit from heightened situational awareness and

the real-time projection of expertise into and out of the battlefield. In future battle spaces, vast numbers of sensors and unmanned vehicles will be in simultaneous use, each with different sensing capabilities providing disparate views of the operations around, above, and below. Networked operations will enable a paradigm shift from passive data collections to active interrogation and the instantaneous, synchronized exploitation of actionable information. Both the recognition and authoritative communication of actionable information requires tight integration of planning and collection processes so what is relevant and what is present can be readily negotiated.

This program supports research in network centric operations with an emphasis on process integration and information forensics. The goal of process integration is to decrease processing loads while increasing functionality through cooperation and leveraging of networked skills. Process integration seeks to sustain the “network effect” where network utility increases as new users, new services, and new information are added. Information forensics examines the extraction and analyses of information for security applications and investigates information processes on an enterprise scale. In application to defense, our objective is to extend information forensics techniques and standards to the identification of precursors representing opportunity and/or risk to networked operations and authoritative communication of actionable information.

Topics include:

- Novel techniques to predict, foster, and quantify “network effect” such that distributed populations of users share information and skills to a measurable increase in productivity and resource management.
- Deep information extraction and information forensics---respectively, assigning meaning and consequences to information;
- Basic research in ubiquitous computing, the development and deployment of mobile applications in domains that require dynamic and adaptive coordination among mobile devices, sensors embedded in the environment, and other components integrated into a dynamic mobile network.
- Techniques that process/manage structured and semi-structured content of data for modeling, querying, routing, execution, visualization, orientation, and application to multiple processes.
- Techniques that deconstruct the composition of discovered information to discern the intent of its author and target audience and the ranked value of data as depicted in the composition.
- Active querying services to establish and evolve publish/subscribe services, also to provide discover and access to networked experts and their workflows.
- Coding, efficient representation, and exploitation of workflows and policy management.
- Quantifications of utility, i.e., workflow effectiveness, efficiency, and satisfaction;
- Mechanisms for learning, tracking, and managing relationships, behavior, community generation, group hierarchy, membership, common practices, and roles and responsibilities as they emerge and evolve among the network's users and agents through their use and customization of shared information spaces; peer review strategies among users, agents, and information management systems.

- Artificial language generation, i.e., sub-symbolic to symbolic translations; concepts in vagueness, particularly the application of overloaded symbols in pattern recognition tasks.
- Cross-domain representation and management of multi-modal, multi-resolution signals (e.g. video, images, audio, hyperspectral, etc.) for efficient transmission, storage, manipulation, multi-modal data mining, and machine learning, particularly in multi-level security environments.
- Fusion and querying of new, incomplete, uncertain, and/or contradictory data; metrics quantifying the value and risk added by new information, processes, and modalities.
- Mechanisms for determining the relevance and certainty of queries and assertions respectively and for determining the quality of processes that produce them. Modeling of query sources (e.g. planning processes) versus assertion sources (e.g. sensor management systems) to predict and facilitate information flow within the network fabric including the management of surprising questions and answers.
- Query processing for large-scale sensor networks; trade offs ranking query functionality vs. limited power, bandwidth, and other concerns; coping with vigilant sensors, mobile sensors, unreliable sensors, and high data rates.
- Stack analyses of evolutionary networks; cooperative control mechanisms in democratic networks (maintaining rule of law).
- Basic research in biometrics, robotic sensing, and mixed initiative surveillance and reconnaissance.
- Basic research in high performance computing and distributed intelligence including foundational work in cognitive computing and polymorphous computing;
- Multidisciplinary and cross-domain approaches are highly encouraged especially if useful in the development of metrics for dynamics, complexity and usability.

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Optimization and Discrete Mathematics

Our goal is to develop mathematical methods for solving large or complex problems, such as those occurring in logistics, target tracking, engineering design, strategic planning, and homeland defense. These problems can often be formulated as mathematical programs. Therefore, research is directed at new linear and nonlinear programming methods, especially when formulated for the solution of selected Air Force problems, and innovative techniques that combine the use of artificial intelligence and operations research. Modern problems require new analytic techniques for development of robust plans under dynamic changes and uncertainty; that is, plans which perform well under a range of possible scenarios and can be changed to accommodate new conditions with minimal perturbation. The new techniques will enhance our existing research in robust optimization and stochastic programming. In addition, modeling techniques must rapidly accommodate new information such as battle damage assessment and data fusion. These techniques should be designed to handle data that is possibly

incomplete, conflicting, or overlapping. These models will view planning, execution, information acquisition, and replanning as a continuously evolving process.

In addition to the evolution of classical solution algorithms, the program supports research on modern metaheuristics (e.g. tabu search, ant colony optimization, evolutionary computing). Of particular interest are algorithms that combine classical optimization and metaheuristic search. Supported research includes discrete event systems, especially large-scale systems related to Air Force transportation, command and control systems, battlefield management, and homeland defense.

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Sensing, Surveillance, Navigation

This research activity is concerned with the systematic analysis and interpretation of variable quantities that represent critical working knowledge and understanding of the changing Battlespace. "Signals Communication" is a sub-area referring to the conveyance of information physically through a channel. Surveillance images are of special importance in targeting, damage assessment and resource location. Signals are either naturally generated or deliberately transmitted, propagated as electromagnetic waves or other media, and recaptured at the receiving sensor. Modern radar, infrared, and electro-optical sensing systems produce large quantities of raw signaling that exhibit hidden correlations, are distorted by noise, but still retain features tied to their particular physical origin. Statistical research that treats spatial and temporal dependencies in such data is necessary to exploit its usable information. An outstanding need in the treatment of signals is to develop resilient algorithms for data representation in fewer bits (compression), image reconstruction/enhancement, and spectral/frequency estimation in the presence of external corrupting factors. These factors can involve deliberate interference, noise, ground clutter, and multi-path effects. This AFOSR program application of sophisticated mathematical methods, including time-frequency analysis and generalizations of the Fourier and wavelet transforms, that deal effectively with the degradation of signaling transmission across a channel. These methods hold promise in the detection and recognition of characteristic transient features, the synthesis of hard-to-intercept communications links, and the achievement of faithful compression and fast reconstruction for audio, video, and multi-spectral data. New combinations of known methods of asset location and navigation are being tried, based on analysis and high-performance computation that bring a force-multiplier effect to command/control capabilities. Continued upgrade and reliance on Global Positioning System makes is critical to achieve GPS-quality positioning in situations GPS by itself is not sufficient. Ongoing research in Inertial and non-Inertial navigation methods (including optical flow and use of signals of opportunity) will bring location precision and reliability to a superlative level. Continuous improvement in its repertoire of signal processing and statistical tools will enable the Air Force to maintain its lead in Battlespace awareness through navigation and surveillance. Communications are what hold

together the networked Infosphere and cost-effective systems innovations that enable phenomenal air power projection.

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Software and Systems

The goal of this program is to enable development of advanced computing and networking science methods, models, and algorithms to support future Air Force systems. Research is sought to meet several challenges, including efficient collection, control, and integration of the vast amounts of information flowing through relevant networks and information spaces. The development of the mathematical foundations of system, software, and network architectures, including key metrics, abstractions, and analytical tools is a critical issue. Research is sponsored into how to make the best use of uncertain information; share and disseminate information; increase the accuracy, speed, and economy of the recognition and identification process; and aid the intelligence analyst. The program seeks to develop technology that will support decision-making. To that end, research is needed to develop intelligent agents capable of gathering information, reducing data to a manageable amount of essential information, and cooperating with other agents to solve problems.

The security of software in Air Force systems and the protection of information is an important issue within this program. For network protection, researchers will focus on determining and analyzing network security properties at all network layers and examining how to ensure that a network possesses these properties. New approaches to detection of intrusion, forensics, and active response and recovery from an attack on information systems, are needed. Basic research that anticipates the nature of future information system attacks is critical to the survivability of these systems. Techniques to automatically detect deceptive data or information are of interest.

Another key issue is how to effectively incorporate all available information, from diverse sources and modalities, into the decision process. For example, mathematical foundations of information fusion must be established -- robust, integrated fusion architectures for handling increasing diversity of input sources are especially important. Information fusion, above the sensor level, to include situation refinement, impact assessment and process refinement is a major focus.

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Information Fusion and Artificial Intelligence

The timely management of information and the ability to make decisions based on that information is of paramount importance within this program. The key issue that is addressed is how to effectively incorporate all available information, from diverse sources and modalities, into the decision process. For example, mathematical foundations of information fusion must be established -- robust, integrated fusion architectures for handling increasing diversity of input sources are especially important. Information fusion, above the sensor level, to include situation refinement, impact assessment and process refinement is a major focus. Research is sponsored into how to make the best use of uncertain information; share and disseminate information; increase the accuracy, speed, and economy of the recognition and identification process; and aid the intelligence analyst.

The program concentrates on research needed to develop large-scale intelligent systems that can address practical Air Force needs. To that end, means are sought to scale up those methods that work for small knowledge-based systems. One goal is to overcome present limitations in the amount of knowledge used because of knowledge acquisition and management deficiencies. Present limitations on meaningful systems adaptation and system improvement with use also need to be overcome. Formalisms need to be developed for the representation of and reasoning with uncertainty, in handling corrupt information, identifying deceptive information, and effectively using experiences.

To aid the information analyst in fusing information from diverse modalities, we seek means to combine numeric and symbolic inference methods. Research could also focus on integrating probabilistic reasoning methods with traditional formal logic methods, and perhaps with other forms of computation. Qualitative methods that will drastically simplify computation and increase performance robustness are also of interest.

The program seeks to develop technology that will support decision-making. To that end, research is needed to develop intelligent agents capable of gathering information, reducing data to a manageable amount of essential information, and cooperating with other agents to solve problems. Research is also needed to combine artificial intelligence methods with operations research tools to overcome inefficiencies in solving some mission-critical Air Force problems (e.g., scheduling in a distributed, dynamic environment).

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Socio-Cultural Modeling

This program seeks fundamental understanding of the interactions between demographic groups both to create understanding for technology developments for enhanced cooperation, such as operational decision making with coalition partners, and to explain and predict outcomes between competing factions within geographic regions.

This program encourages collaboration between, for example, social, behavioral, economic, and political scientists with computational researchers in artificial intelligence, control theory, and adaptive systems. Example topics include: (1) Exploring the structure of cultural knowledge, beliefs, and social norms either broadly, in factor models, or more narrowly, within the framework of a computational cognitive architecture; (2) Reasoning and decision-making processes in cultural context, including reasoning with uncertain information; (3) Self-organization and adaptation of culturally defined entities or groups, including models of group competitive and cooperative interactions; (4) Game-theoretic modeling of interactive agents with imperfect and incomplete information regarding other agents; (5) New approaches to automated reasoning about belief, knowledge, obligation, time, and preference; and (6) Characterization of interacting dynamics at multiple scales, from individual to nation-state.

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Education and Outreach Programs

The External Programs and Resources Interface Division (PIE) of the Air Force Office of Scientific Research (AFOSR), the International Office (IO), and two overseas detachments, AOARD and EOARD, are responsible for the management of several programs that improve science and engineering education in the U.S., and stimulate interactions between Air Force researchers and the broader international, as well as domestic, research community. Applications for these programs do not always require proposals but generally have specific deadlines, formats, and qualifications. Researchers applying for these programs should communicate with the point-of-contact (POC) listed in each program description.

United States Air Force National Research Council Resident Research Associateship (USAF-NRC/RRA) Program

The NRC/RRA Program offers postdoctoral and senior scientists and engineers opportunities to perform research at sponsoring Air Force laboratory sites. The objectives of this program are: (1) to provide researchers of unusual promise and ability opportunities to solve problems, largely of their own choice, that are compatible with the interests of the hosting laboratories; and (2) to contribute to the overall efforts of the Air Force laboratories.

Postdoctoral Research Associateships are awarded to U.S. citizens and permanent residents who have held doctorates for less than five years at the time of application. The awards are made initially for one year and may be renewed for a second year, and in some cases, a third year. A small number of associateships may be available for foreign citizens if laboratory funds are available.

Senior Research Associateships are awarded to individuals who have held doctorates for more than five years, have significant research experience, and are recognized internationally as experts in their specialized fields, as evidenced by numerous refereed journal publications, invited presentations, authorship of books or book chapters, and professional society awards of international stature. Although awards to senior associates are usually for one year, awards for periods of three months or longer may be considered. Renewals for a second and third year are possible. U.S. citizenship is not a requirement. Senior associates must be eligible for access to unclassified government information systems; eligibility is also subject to a successful background review and visit authorization that includes approved access to the Air Force base and its laboratory facilities.

Associates are considered independent contractors, and receive a stipend from the NRC while carrying out their proposed research. Annual stipends increase with additional years past the Ph.D. An appropriately higher stipend is offered to senior associates. Awardees also receive a relocation reimbursement and may be supported with limited funds for professional travel.

An on-line application is available at: <http://www.nationalacademies.org/rap>.

The program is currently administered by The National Research Council (NRC):
Research Associateship Programs (GR322K)

National Research Council

500 Fifth St, NW, Washington DC 20001

(202) 334-2760

E-mail: rap@nas.edu

<http://www.nationalacademies.org/rap>

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United States Air Force-Summer Faculty Fellowship Program (USAF-SFFP)

The SFFP offers fellowships to university faculty to conduct research at Air Force research facilities in the summer. The objectives of the Summer Faculty Fellowship Program are to: (1) stimulate professional relationships among SFFP

fellows and the scientists and engineers in AFRL Technical Directorates and other Air Force research facilities; (2) elevate the awareness in the U.S. academic community of Air Force research needs and foster continued research at SFFP fellows' institutions; and (3) provide the faculty opportunities to perform high-quality research at AFRL Technical Directorates and other Air Force research facilities.

SFFP fellows conduct research in collaboration with Air Force researchers for a continuous summer period of eight to twelve weeks at the Technical Directorates of the Air Force Research Laboratory, the US Air Force Academy, or the Air Force Institute of Technology. A final report is required at the completion of the summer appointment.

Applicants must be U.S. citizens or permanent residents and have an earned Ph.D. in science or engineering. Fellows must be eligible for access to unclassified government information systems; the fellowship award is subject to a successful background review and visit authorization that includes approved access to an Air Force installation and its laboratory facilities.

Fellows are awarded in different categories including both early career investigator and senior investigator. The stipend is based on the category. Each SFFP award is for one summer. The SFFP fellow may reapply for up to two additional summers, for a maximum of three summer awards.

An on-line application is available at: <http://www.asee.org/sffp/>.

The program is currently administered by The American Society for Engineering Education (ASEE):

American Society for Engineering Education
1818 N St, NW Suite 600
Washington DC 20036
<http://www.asee.org/sffp>

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Engineer and Scientist Exchange Program (ESEP)

The Engineer and Scientist Exchange Program (ESEP) is a DOD effort to promote international cooperation in military research, development, and acquisition through the exchange of defense scientists and engineers (S&E). A prerequisite for establishing the program is a formal international agreement, a Memorandum of Understanding (MOU), with each participant nation. Currently, DoD has signed ESEP agreements with Australia, Canada, Egypt, France, Germany, Greece,

Israel, Japan, Norway, Poland, Portugal, Republic of Korea, Singapore, Sweden, Spain, The Netherlands, and the United Kingdom. The primary goals of ESEP are to:

- Broaden perspectives in research and development techniques and methods.
- Form a cadre of internationally experienced professionals to enhance USAF research and development programs.
- Gain insight into foreign research and development methods, organizational structures, procedures, production, logistics, testing, and management systems.
- Cultivate future international cooperative endeavors.
- Avoid duplication of research efforts among allied nations. Air Force personnel are selected in a competitive process and are assigned for a 2-year tour.

This may be preceded by 6 months of language training. Ad hoc placements (non-competitive) can be initiated by research sites; however, these are funded solely by their originators. Foreign S&E are usually assigned to US DoD organizations for 12 month periods; although assignments can be for shorter or longer duration. Each country bears the cost of supporting its participants in the program. AFOSR/IO is responsible for managing placement of all ESEP exchanges within the USAF, and is the "one face to the customer" for all USAF ESEP actions. SAF/IAPQ (Armaments Cooperation Division, Deputy Under Secretary of the Air Force, International Affairs), the executive agent, provides policy guidance. The Asian and European Offices of Aerospace Research and Development (AOARD/EOARD) is AFOSR field offices located in Tokyo and London. These offices act as overseas program liaison offices for US ESEP personnel working in Asia and Europe.

AFOSR/IO implements all actions for USAF participants once their selection is approved, and for the placement of foreign ESEP participants in Air Force organizations.

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Air Force Scientist Visiting Researcher Program

The AF Scientist Visiting Researcher Program provides outstanding Air Force scientists and engineers the opportunity to conduct full-time, "hands-on" research-

related work in leading U.S. University and industry laboratories for a period of up to 179 days on a temporary duty status funded by AFOSR. The university or industrial laboratory provides a letter of invitation, and makes facilities, equipment, and resources available. The host laboratory must be located in the United States. Typically the researcher is an Air Force scientist or engineer, at least at the GS-13 level or its military equivalent. The applicant must be currently active in his or her field of expertise, be widely recognized as an expert, and have a strong publication record. The applicant must write a project proposal, preferably not to exceed ten pages, but of sufficient depth and scope for evaluation by scientists at participating organizations. Hands-on laboratory research-related work is an essential program element. At the completion of the TDY, the visiting researcher is required to submit a written report detailing his or her experiences and results of the project. In addition, the visiting researcher may be required to give a seminar presentation at the Air Force laboratory or at AFOSR and to provide feedback for purposes of program assessment. Upon completion of the assignment the researcher returns to his or her Air Force laboratory.

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Window on Science (WOS) Program

The Window on Science (WOS) program facilitates technical interactions on fundamental research via direct contact between distinguished foreign researchers and Air Force Research Laboratory scientists and engineers. The WOS program sponsors foreign scientists and engineers to visit Air Force scientists and engineers at USAF sites typically within the U.S., but may also include other domestic or overseas locations. Although WOS visits are designed to be short-term in nature, visits to multiple sites are encouraged. In order to present their research to a greater audience, and to further Air Force interests, WOS visitors may also combine visits to Air Force R&D organizations with visits to Army, Navy, other government, university, or industrial facilities. The AFOSR international Detachment 1, the European Office of Aerospace Research and Development (EOARD), London, United Kingdom, manages this program for Europe, Africa, the Middle East, and countries of the former Soviet Union. Detachment 2, the Asian Office of Aerospace Research and Development (AOARD), Tokyo, Japan manages this program for the remainder of Asia and the Pacific Rim. The International Office, AFOSR/IO, located within the main body of AFOSR, manages the program for the Americas. Participants in the WOS program will be foreign researchers identified as subject matter experts by AFRL program managers, and whose visit benefits Air Force scientists and engineers. Travelers may be eligible to receive payment for their services; however, base clearance requests for unpaid non-government visitors can also be handled under the WOS program. Visitors will

normally present seminars to discuss their work, which may or may not have been funded by the Air Force. The WOS program is not intended as a substitute for research programs, internships, associateships, or personnel exchange programs. The lead-time necessary to arrange a WOS visit is generally three months. A letter report from the traveler is required on completion of the visit.

EOARD: <http://www.london.af.mil/>

AOARD: <http://www.tokyo.afosr.af.mil/>

International Office: <http://afosr-io.afosr.af.mil/>

Window on Europe (WOE), Window on Asia (WOA), and Window on the Americas (WOAm) Programs

The Window on Europe, Window on Asia, and Window on the Americas programs provide outstanding Air Force scientists and engineers the opportunity to conduct full-time research at a foreign host laboratory, or to perform full-time science and technology assessment activities for a period up to 179 days on temporary duty (TDY) status. The TDY is fully funded by AFOSR. Upon completion of the assignment the researcher returns to his or her Air Force activity. The host laboratory provides facilities, resources, and a letter of invitation. Typically the researcher is an Air Force scientist or engineer, at least at the GM/GS-13 level or its military equivalent. The researcher must be currently active in his or her field of expertise, be widely recognized as an expert, and have a strong publication record. Some knowledge of the language used by the researcher's host institution is desirable. The applicant must write a research proposal, preferably not to exceed 10 pages, but of sufficient depth and scope, so that it can be evaluated by the scientists at the participating organizations. The proposal must be endorsed by the applicant's Air Force Research Laboratory Technical Directorate Chief Scientist. Non-laboratory applicants, such as researchers at the Air Force Academy and Air Force Institute of Technology, should pass their proposals through the Chief Scientist of an AFRL Technical Directorate. Proposals that focus tightly on specific research problems or specific science and technology assessment topics will merit greater consideration than those that are of a survey nature. The researcher is required to submit a written report detailing his or her research effort and findings at the completion of the TDY. In addition, the researcher may be required to give a seminar-style presentation at the Air Force laboratory and/or at AFOSR and provide feedback for purposes of program assessment. Lead-time to set up a "Window" visit is approximately four months. More detailed information is contained in the AFOSR Brochure, "International Window Programs."

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National Defense Science and Engineering Graduate (NDSEG) Fellowship Program

The NDSEG Fellowship Program is a Department of Defense (DoD) fellowship program sponsored by Air Force Office of Scientific Research (AFOSR), Army

Research Office (ARO), Office of Naval Research (ONR), and the High Performance Computing Modernization Program (HPCMP). The DoD is committed to increasing the number and quality of our Nation's scientists and engineers. The actual number of awards varies from year to year, depending upon the available funding. The NDSEG Fellows do not incur any military or other service obligations. NDSEG Fellowships are highly competitive and will be awarded for full-time study and research.

An awardee must be enrolled in a graduate program by Fall 2007; the graduate program must lead towards a Ph.D. Preference will be given to applicants in one, or closely related to one, of the following specialties: Aeronautical and Astronautical Engineering; Biosciences; Chemical Engineering; Chemistry; Civil Engineering; Cognitive, Neural and Behavioral Sciences; Computer and Computational Sciences; Electrical Engineering; Geosciences; Materials Science and Engineering; Mathematics; Mechanical Engineering; Naval Architecture and Ocean Engineering; Oceanography; and Physics.

The NDSEG Fellowship Program is open only to applicants who are citizens or nationals of the United States. Persons who hold permanent resident status are not eligible to apply. NDSEG Fellowships are intended for students at or near the beginning of their graduate study in science or engineering. Applications are encouraged from women, persons with disabilities, and members of ethnic and racial minority groups historically underrepresented in science and engineering fields, including African American, American Indian and Alaska Native, Native Hawaiian and Pacific Islander, and Hispanic persons.

The duration of an NDSEG Fellowship is thirty-six months cumulative starting in the fall of an academic year. NDSEG Fellows may choose as their fellowship institution any accredited U.S. institution of higher education offering doctoral degrees in science or engineering. The availability of funds for the second and third years of each three-year award is contingent upon satisfactory academic progress.

In FY2006 NDSEG fellowships will provide stipends of \$30,500, \$31,000 and \$31,500 in the first, second, and third years, respectively. Additionally, the NDSEG fellowship will pay the fellow's full tuition, required fees (not to include room and board) and minimum health insurance coverage offered through the institution, up to a total value of \$1,000. Any excess insurance costs will be the responsibility of the fellow and can be paid using the stipend. The stipends will be prorated monthly based on a twelve-month academic year. If the fellow is not enrolled in an institutionally approved academic study and/or research during the summer months, financial support will not be provided. There are no dependency allowances. Persons with disabilities will be considered for additional allowances to offset special educational expenses.

An on-line application is available at: <http://www.asee.org/ndseg>.

This program is currently administered by the American Society for Engineering Education (ASEE):

NDSEG Fellowship Program c/o American Society for Engineering Education:
1818 N Street, N. W.

Suite 600 Washington, D. C., 20036 (202) 331-3516 Fax: (202) 265-8504 E-mail:
ndseg@asee.org
<http://www.asee.org/ndseg>

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The Awards to Stimulate and Support Undergraduate Research Experiences (ASSURE)

The ASSURE program supports undergraduate research in DoD relevant disciplines and is designed to increase the number of high-quality undergraduate science and engineering majors who ultimately decide to pursue advanced degrees in these fields. A strong U.S. science and engineering workforce is of clear interest to the DoD, as the capability of producing superior technology is essential for future national security.

The ASSURE program aims to provide valuable research opportunities for undergraduates, either through ongoing research programs or through projects specially designed for this purpose. Research projects should allow high quality interaction of students with faculty and/or other research mentors and access to appropriate facilities and professional development opportunities. Active research experience is considered one of the most effective ways to attract and retain talented undergraduates in science and engineering.

ASSURE projects must have a well-defined common focus that enables a research related experience for students. Projects may be based in a single discipline or academic department, or interdisciplinary or multi-department research opportunities with a strong intellectual focus. Each proposal should reflect the unique combination of the proposing institution's interests and capabilities. Applicants are encouraged to involve students in research who might not otherwise have the opportunity, particularly those from institutions where research programs are limited. Thus, a significant fraction of the student participants should come from outside the host institution. In addition, DoD is interested in strengthening institutions with limited research programs and especially encourages proposals that help to enhance the research infrastructure in predominantly undergraduate four-year institutions. Student participants must be citizens or permanent residents of the United States or its possessions.

The DoD ASSURE budget is \$4.5 million annually. DoD expected ASSURE budget for new projects is approximately \$1.5 million; this funding will be distributed among fifteen to twenty new ASSURE awards. DoD relevance will be considered in making funding decisions. Projects may be carried out during the summer months, during the academic year, or both. Sites may be proposed for durations of one to five years, with a three-year duration being typical.

DoD executes the ASSURE program collaboratively with the National Science Foundation (NSF) through its Research Experiences for Undergraduates (REU) Sites Program. DoD funded ASSURE sites will be selected by DoD scientists and

engineers, but will be overseen by NSF as part of the NSF portfolio of REU Sites. There is no separate application for the ASSURE program; ASSURE funding is awarded through the NSF REU Sites Program.

Information about the NSF REU Program can be found at NSF Program Solicitation NSF 05-592: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5517. Applications are submitted through NSF Fastlane, <https://www.fastlane.nsf.gov/fastlane.jsp>.

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Special Programs

AFOSR provides the support for research and education through the following unique programs: The Small Business Technology Transfer Program (STTR); the Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) Program; and the University Research Initiative (URI) Program. Other support deemed appropriate by AFOSR, such as conferences and workshops, may also be sponsored.

Small Business Technology Transfer Program (STTR)

AFOSR will have multiple topics in the FY07 DoD Solicitation cycle that will be announced around 1 February 2007. These topics are for basic research in areas of special interest to the Air Force.

The primary objective of the AF STTR program is to involve small businesses in AF-relevant defense research, and enable them to commercialize their innovative technologies for the advancement of U.S. economic competitiveness. Specifically, the STTR Program is designed to provide an incentive for small companies, academic institutions, and non-profit research institutions, including federally-funded research and development centers (FFRDC), to work together to move emerging technical ideas from the laboratory to the marketplace.

Each STTR proposal must be submitted by a team that includes a small business (as the prime contractor for contracting purposes) and at least one academic or non-profit research institution, which have entered into a Cooperative Research and Development Agreement for the proposed effort. The STTR has two phases: Phase I efforts are up to \$100,000 for a period not to exceed one year; and Phase II projects are less than 24-month efforts for amounts up to \$750,000. More information regarding the AF STTR can be found at: <http://www.afri.af.mil/sbir>.

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Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) Program

AFOSR HBCU/MI program consists of two main components:

AFOSR Core Research. Research proposals from HBCU/MI are reviewed by AFOSR Program Managers as part of their core program and may be funded from funds set aside by the AFOSR Director.

Department of Defense Infrastructure Support Program for Historically Black Colleges and Universities and Minority Institutions. The DoD has been providing grants for research and educational equipment at HBCU/MI. This program is administered by the Army Research Office, in collaboration with the AFOSR. Schools interested in this program should look for the Broad Agency Announcement that is usually published in October each year in the ARO webpage. The BAA is linked through the AFOSR Web site at <http://www.afosr.af.mil>, under “For Researchers”; “Special Programs” at http://www.afosr.af.mil/ResearchAreas/special_hbcumi.htm.

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Young Investigator Research Program (YIP)

The AFOSR’s YIP supports scientists and engineers who have received a Ph.D. or equivalent degrees in the last five years, and show exceptional ability and promise for conducting basic research. The objective of this program is to foster creative basic research in science and engineering; enhance early career development of outstanding young investigators; and increase opportunities for the young investigator to recognize the Air Force mission and related challenges in science and engineering.

Individual awards will be made to U.S. institution of higher education, industrial laboratory or non-profit research organization where the principal investigator is U.S. citizen, national or permanent resident; employed on a full-time basis and hold a regular position. Each award will be funded at the \$100K level per year for three years. Researchers working at the Federally Funded Research and Development Centers and DoD Laboratories will not be considered for the YIP competition. Specific information about YIP can be found at AFOSR Web site at <http://www.afosr.af.mil>, under “For Researchers”; “Special Programs”; “Young Investigator Program” to download a “.pdf” file.

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University Research Initiative (URI) Programs

The URI programs are executed under the policy guidance of the Office of the Deputy Under Secretary of Defense for Laboratories and Basic Research, to enhance universities' capabilities to perform basic science and engineering research and related education in science and engineering areas critical to national defense. The URI programs include: the Defense Research Instrumentation Program (DURIP); the Multidisciplinary Research Program of the University Research Initiative (MURI); the Defense University Research Initiative on NanoTechnology (DURINT); and the Critical Infrastructure Protection (CIP) and High Confidence, Adaptive Software (SW) program. A short description of each program is listed below. Specific information on each URI program Broad Agency Announcement can be found on the AFOSR Web site at <http://www.afosr.af.mil>, under "For Researchers" at http://www.afosr.af.mil/ResearchAreas/special_muri.htm.

Defense University Research Instrumentation Program (DURIP)

This program is administered through the Air Force Office of Scientific Research, the Army Research Office, and the Office of Naval Research. The DURIP program is for the acquisition of major equipment to augment current or develop new research capabilities to support research in the technical areas of interest to the DoD. The competition is open only to U.S. institutions of higher education, with degree granting programs in science, math, and/or engineering. Proposals to purchase instrumentation may request \$50,000 to \$1,000,000. Awards are typically one year in length. The BAA is linked through the AFOSR webpage AFOSR Web site at <http://www.afosr.af.mil>, under "Research Opportunities" at http://www.afosr.af.mil/ResearchAreas/research_opportunities.htm.

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Multidisciplinary Research Program of the University Research Initiative (MURI)

This program is administered through the Army Research Office, the Office of Naval Research, and the Air Force Office of Scientific Research. The Multidisciplinary Research Initiative (MURI) supports university research efforts intersecting more than one traditional science and engineering discipline.

Multidisciplinary research teaming not only accelerates research progress in areas particularly suited to this approach by cross-fertilization of ideas but also help to hasten the transition of basic research findings to practical application. By supporting team efforts, MURI complements other DoD programs that support university research through single-investigator awards. Awards are typically for a period of three years with two additional years possible as options. The funding level ranges typically from \$0.5M to \$1M per year. Starting FY2007, the new awards will be up to \$1.5M per year, with the actual amount contingent on the availability of funds, the specific topic, and the scope of the proposed work. The MURI is competed in specific research topics described in the current MURI announcement at <http://www.afosr.af.mil>, under "For Researchers," http://www.afosr.af.mil/ResearchAreas/special_muri.htm.

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The Department of Defense Experimental Program to Stimulate Competitive Research (DEPSCoR)

This program is executed under the policy guidance of the Office of the Deputy Under Secretary of Defense for Laboratories and Basic Sciences [ODUSD (LABS)] and administered through the Army Research Office (ARO), Office of Naval Research (ONR), and Air Force Office of Scientific Research (AFOSR) with the cooperation of the Experimental Program to Stimulate Competitive Research (EPSCoR) State Committees. The DoD, including AFOSR, plans to award fiscal year 2007 DEPSCoR appropriations through the DEPSCoR announcement.

DEPSCoR objectives are to: (1) enhance the capabilities of institutions of higher education ("universities") in eligible States to develop, plan, and execute science and engineering research that is competitive under the peer review systems used for awarding Federal research assistance; and (2) increase the probability of long term growth in the competitively awarded financial assistance that universities in eligible States receive from the Federal Government for science and engineering research. Consistent with these long term objectives of building research infrastructure, the DoD intends to competitively make multiyear awards for research and for associated graduate education of scientists and engineers in areas important to national defense. Universities in EPSCoR states/territories with degree granting programs in science, mathematics, and/or engineering are eligible to submit proposals for DEPSCoR research grants via their EPSCoR State Committee. Each EPSCoR State Committee will decide which DEPSCoR proposals will be forwarded to DoD. Eligible EPSCoR State Committees may submit a proposal package containing up to five (5) separately fundable proposals requesting support from DoD for a 36-month period. Within the state proposal package, all proposals must request a minimum of \$350,000. To maximize the DEPSCoR program objectives, all DEPSCoR awards require a minimum non-federal cost sharing or matching of one-to-two (i.e., at least one dollar from State, institutional, and/or private sector sources to match each two dollars of DEPSCoR support being provided). Matching funds may support items such as salaries, indirect costs, operating expenses, or new equipment. Universities in 27 States and Territories are eligible to receive awards under this announcement.

STATES AND TERRITORIES CURRENTLY ELIGIBLE FOR DEPSCoR AWARDS

Alaska	Arkansas	Delaware	Hawaii	Idaho
Kansas	Kentucky	Maine	Montana	Nebraska
Nevada	New Hampshire	North Dakota	Oklahoma	Puerto Rico
Rhode Island	South Carolina	South Dakota	Tennessee	Vermont
West Virginia	Wyoming	U.S. Virgin Islands		
Alabama	Louisiana	Mississippi		
New Mexico				

DEPSCoR research projects may address any of the technical areas listed in the respective Army, Navy, and Air Force' BAAs. BAAs and program descriptions are available on-line at the following addresses:

Air Force Office of Scientific Research: <http://www.afosr.af.mil> , under "For Researchers," http://www.afosr.af.mil/ResearchAreas/special_depscor.htm .

U.S. Army Research Office: <http://www.aro.army.mil> , under "For the Researcher"; "Funding Opportunities," <http://www.aro.army.mil/research/index.htm> .

Office of Naval Research: <http://www.onr.navy.mil> , under ONR Science & Technology Departments, "Office of Transition (Code 03T), "Corporate Programs Division," http://www.onr.navy.mil/sci_tech/3t/corporate/.

Proposals to perform research in listed technical areas, or other areas important to national defense, will be considered. For detailed information regarding technical goals, individuals preparing proposals are advised to consult these announcements and to contact DoD program managers listed therein to explore possible mutual interest before submitting proposals.

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Presidential Early Career Award in Science & Engineering (PECASE)

The National Science & Technology Council (NTSC) sponsors PECASE awards to recognize outstanding young scientists and engineers at the outset of their careers. The PECASE embodies the high priority placed by the President on maintaining the leadership position of the US in science by producing outstanding scientists and engineers and nurturing their continued development. The Awards will identify a cadre of outstanding scientists and engineers who will broadly advance science and the missions important to the participating agencies.

The PECASE recognize some of the nation's finest scientists and engineers who, while early in their research careers, show exceptional potential for leadership at the frontiers of scientific knowledge during the 21st century. The Awards foster innovative and far-reaching developments in science and technology, increase awareness of careers in science and engineering, give recognition to the scientific missions of participating agencies, enhance connections between fundamental research and national goals, and highlight the importance of science and technology for the nation's future. The awards are conferred annually at the White House following recommendations from participating agencies.

To be eligible for the PECASE, an individual must be a US citizen, national, or permanent resident with no more than five years from receipt of the doctorate degree. Each award will be \$200K per year for five years. AFOSR awardees will be selected from among highly qualified institute of higher education principal investigators to the AFOSR or former National Defense Science and Engineering Graduate (NDSEG) fellowship recipients. Candidates must hold tenure-track positions at U.S. universities. An individual wishing to apply for the program must be nominated by an AFOSR program manager and have a proposal that addresses Air Force research interests as described in the current AFOSR Broad Agency Announcement (BAA).

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Partnerships for Research Excellence and Transition (PRET)

The PRET Program is a university-based research program of excellence involving strong industrial ties to accelerate the transition of research results to industry. This program is designed to broaden the university base in support of defense research, strengthen university-industry cooperation, and improve U.S. competitiveness in areas of dual use. The goal of the program is to fund quality research and concurrently establish and support a deliberate exchange of scientific personnel between academia and industry. The areas to be supported are found in Section III of this announcement. Proposals will be evaluated on:

- (1) The scientific and technical merits of the proposed research.
- (2) The potential contributions of the proposed research to the mission of the Air Force.
- (3) The proposed interface between university and industry for the purpose of transitioning the generated information; also significant, but of lesser importance are:
 - a. The likelihood of the proposed effort to develop new research capabilities and broaden the research base in support of national defense;
 - b. The proposer's key personnel qualifications, capabilities, related experience, facilities, or techniques or a combination of these factors that is integral to achieving Air Force Objectives;
 - c. The proposer's and associated personnel's record of past performance; and

- d. The realism and reasonableness of proposed costs and availability of funds.

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All responsible, potential applicants from academia and industry are eligible to submit proposals. AFOSR particularly encourages proposals from small businesses, historically black colleges and universities, minority institutions and minority researchers. However, no portion of this BAA is set aside for a specific group. Cost sharing is encouraged but not required.

Conferences and Workshops

The Air Force Office of Scientific Research (AFOSR) understands that it is essential for the scientific community to maintain clear lines of communication for thorough and well-reasoned research to be accomplished. Support for conferences and workshops have proven to be an extremely valuable tool for AFOSR. They allow our technical managers the opportunity to receive current information in their respective disciplines. They also allow AFOSR the opportunity to inform the research community of the current thrust of AFOSR's programs. Conferences and workshops constitute a key forum for research and technology interchange. AFOSR accepts proposals from all recognized scientific, technical, or professional organizations that qualify for federal tax-exempt status. AFOSR's financial support through appropriate financing vehicles for conferences and workshops is dependent on the availability of funds, program manager's discretion, and certain other restrictions including:

- AFOSR support for a workshop or conference is not to be considered as an endorsement of any co-sponsoring organization, profit or non-profit.
- The subject matter of the conference or workshop is scientific, technical, or involves professional issues that are relevant to AFOSR's mission of managing the Air Force basic research program.
- The purpose of our support is to transfer federally developed technology to the private sector or to stimulate wider interest and inquiry into the relevant scientific, technical, or professional issues relevant to AFOSR's mission of managing the Air Force basic research program. Proposals for conference or workshop support should be submitted a minimum of six months Prior to the date of the conference. Proposals should include the following:

Technical Information:

- Summary indicating the objective(s) of the conference/workshop
- Topic(s) to be covered and how they are relevant to AFOSR's mission of managing the Air Force basic research program
- Title, location, and date(s) of the conference/workshop
- Explanation of how the conference/workshop will relate to the research interests of AFOSR identified in Section III of the Broad Agency Announcement (BAA)

- Chairperson or principal investigator and his/her biographical information
- List of proposed participants and method (or copies) of announcement or invitation
- A note whether foreign nationals will be present

Evaluation Criteria For Conference Support:

Anticipated use of funds requested from AFOSR Proposals for conferences and workshops will be evaluated using the following criteria. All factors are of equal importance to each other:

- The scientific and technical relevance of the proposed conference.
- The potential contributions of the proposed conference to the mission of the Air Force.
- The qualifications of the principal investigator(s) or conference chair(s).
- The realism and reasonableness of cost including proposed cost sharing and availability of funds.

Cost Information (In addition to information required on SF 424 (R&R) Budget forms):

- Total project costs by major cost elements
- Anticipated sources of conference/workshop income and amount from each source

If you have questions concerning the scientific aspects of a potential proposal to AFOSR for conference or workshop support, please contact the program manager listed in Section I of the BAA responsible for the particular scientific area of the conference/workshop. If you have questions concerning the eligibility of your organization to receive funding for your conference or workshop, please contact the AFOSR Legal Office at (703) 696-9500.

II. Award Information

In Fiscal Year 2006, AFOSR managed funding support for approximately 1,400 grants, cooperative agreements, and contracts, totaling \$429 million, to about 400 academic institutions and industrial firms. This included grants, cooperative agreement and contracts to academic institutions, non-profit organizations, and industry. Approximately \$200M is available for support of actions award through this BAA process. Awards average \$100,000 per year for three years. Awards may start any time during the fiscal year. AFOSR encourages the sharing and transfer of technology and welcomes proposals that envision cooperation among two or more partners from academia, industry, and Air Force organizations. Non-industry proposers should detail in their proposals their interactions with industry and Air Force organizations, including specific points of contact. AFOSR also encourages proposers to cooperate with and use Air Force facilities; proposers should contact appropriate directorates in the Air Force Research Laboratory for this purpose.

III. Eligibility Information

All responsible, potential applicants from academia and industry are eligible to submit proposals. AFOSR particularly encourages proposals from small businesses, historically black colleges and universities, minority institutions and minority researchers. However, no portion of this BAA is set aside for a specific group. Cost sharing is encouraged but not required.

IV. Application and Submission Information

1. Address to Request Announcement Package – This announcement may be accessed from the Internet from the “Other Opportunities” portion of AFOSR’s web site (<http://www.afosr.af.mil/>) through the “Need Funding?” link

2. Marking of Proposals - Every effort should be made to protect the confidentiality of the proposal and any evaluations. However, under the Freedom of Information Act (FOIA) requirements, such information (or portions thereof) may potentially be subject to release. The proposer must mark the proposal with a protective legend found in FAR Part 15.609, Limited Use of Data, (modified to permit release to outside evaluators retained by AFOSR) if protection is desired for proprietary or confidential information.

3. Content and Form of Application Submission –

a. White Paper. Before submitting a research proposal, you may wish to further explore proposal opportunities. You can do this by contacting the appropriate AFOSR program manager who can provide greater detail about a particular opportunity; the program manager may then ask for a preliminary proposal or white paper. However, in your conversations with a Government official, be aware that only warranted contracting and grants officers are authorized to commit the Government.

If you prefer, or the program manager requests, you may submit a preliminary proposal (White Paper), which should be in letter format and briefly describe the proposed research project’s (1) objective, (2) general approach, and (3) impact of Department of Defense (DoD) and civilian technology. The letter may also contain any unique capabilities or experience you may have (e.g., collaborative research activities involving Air Force, DoD, or other Federal laboratory.) Preliminary proposal letter should not exceed three typewritten pages; example figures and a one page curriculum vita(e) for the principal investigator(s) may be attached.

White Paper Format

- Paper Size – 8.5 x 11 inch paper
- Margins – 1 inch
- Spacing – single or double spaced
- Font – Times New Roman, 10 or 12 point
- Copies –as discussed with the Program Manager
- Content – as described above

b. Full Proposals. The proposal may be submitted either electronically or in hard copy form, but not both. All proposers must include the SF 424 (R&R) form as the cover page. Unnecessarily elaborate brochures, reprints or presentations beyond those sufficient to present a complete and effective proposal are not desired.

Full Proposal Format

- Paper Size – 8.5 x 11 inch paper
- Margins – 1 inch
- Spacing – single or double spaced
- Font – Times New Roman, 10 or 12 point
- Page Limitation – None, although unnecessarily elaborate proposals are not desirable.
- Copies for hardcopy submissions – (one original, number of copies as discussed with the Program Manager)
- Content – as described below

(1) Advance Preparation For Electronic Submission - Electronic proposals must be submitted through Grants.gov. There are several one-time actions your organization must have completed before it will be able to submit applications through Grants.gov. Well before the submission deadline, you should verify that the persons authorized to submit proposals for your organization have completed those actions. If not, it may take them up to 21 days to complete the actions before they will be able to submit applications.

The process your organization must complete includes obtaining a Dun and Bradstreet Data Universal Numbering System (DUNS) number, registering with the Central Contract Registry (CCR), registering with the credential provider, and registering with Grants.gov. (Designating an E-Business Point of Contact (EBiz POC) and obtaining a special password called MPIN are important steps in the CCR registration process.) Go to http://www.grants.gov/applicants/get_registered.jsp. Use the Grants.gov Organization Registration Checklist at <http://www.grants.gov/section3/OrganizationRegCheck.pdf> to guide you through the process. At present, if a proposal is submitted through Grants.gov, PureEdge Viewer will need to be downloaded. This small, free program will allow you to access, complete, and submit applications electronically and securely. For a free version of the software, visit the following web site: www.Grants.gov/DownloadViewer. In the future, Adobe will be used. Should you have questions relating to the registration process, system requirements, how an application form works or the submittal process, call Grants.gov at 1-800-518-4726 or support@Grants.gov for updated information.

(2) Submitting the Application

(a) For Electronic Submission – Application forms and instructions are available at Grants.gov. To access these materials, go to

<http://www.grants.gov>, select “Apply for Grants”, and then select “Download Application Package”. Enter the CFDA number for AFOSR which is 12.800, Air Force Defense Research Sciences Program (AFOSR). You should also enter the funding opportunity number for this announcement (AFOSR BAA 2007-1). Then follow the prompts to download the application package.

The funding opportunity will be listed multiple times. The funding opportunity number is identical for each listing. When you download the instructions and application, select the Competition ID and Competition Title for the directorate specific to your area of interest.

If you are unsure which directorate and program manager is appropriate for your specific area of interest, select the Competition ID and Competition Title “Other” to apply. Your proposal will be forwarded to the appropriate office.

(b) For Hard Copy Submission – For hard copy submission, the original proposal and copies must be delivered to the attention of the program manager at the Air Force Office of Scientific Research at the following address:

AFOSR (Attn: Name of Program Manager)
Air Force Office of Scientific Research
875 North Randolph Street, Room 3112
Arlington VA 22203

In case of difficulties in determining the appropriate AFOSR addressee, proposals may be submitted to:

AFOSR/PKC
875 Randolph Street, Room 3112
Arlington VA 22203-1954

(c) SF 424 Research and Related (R&R) - The SF 424 (R&R) form must be used as the cover page for all electronic and hard copy proposals. No other sheets of paper may precede the SF 424 (R&R) for a hard copy proposal. A signed copy of the SF 424 (R&R) should be submitted with all hardcopy proposals. Complete all the required fields in accordance with the “pop-up” instructions on the form and the following instructions for the specified fields. To activate the instructions, turn on the “Help Mode” in Grants.gov. (The “Help Mode” is turned on by the icon with the pointer and question mark. This is located at the top of the form). The completion of most of the fields is self-explanatory except the following special instructions:

- **Field 2:** In the Applicant Identifier area, please list the appropriate program officer to receive the proposal.
- **Field 3:** The State Application Identifier may be left blank.

- **Field 7:** Complete as indicated. Please note under “Other (Specify)” if your organization is a Minority Institution (MI).
- **Field 8:** Complete fields as indicated.
- **Field 9:** List AFOSR as the reviewing agency.
- **Field 20:** Use Field 20 to attach the proposal narrative as described below.

(d) Other forms: The following other forms must be used for all electronic and hard copy proposals. R&R Budget form, R&R Senior/Key Person Profile form, R&R Project/Performance Site Locations form and R&R Other Project Information form. Forms may be obtained at the grants.gov website.

(e) Certification: All awards require some form of certifications of compliance with national policy requirements.

For assistance awards, i.e., grants and cooperative agreements, proposers using the SF 424 (R&R) are providing the certification required by 32 CFR Part 28 regarding lobbying. (The full text of this certification may be found at http://www.afosr.af.mil/Documents/funding_GrantCertForm.htm or a copy will be provided upon request.)

For contract awards, prospective contractors shall complete electronic annual representations and certifications at <http://www.bpn.gov/orca> in conjunction with required registration in the Central Contractor Registration (CCR) database. Prospective contractors shall update the representations and certifications submitted to ORCA as necessary, but at least annually, to ensure they are kept current, accurate, and complete. The representations and certifications are effective until one year from date of submission or update to ORCA. In addition to the ORCA representations and certifications, prospective contractors shall complete the AFOSR Contract Certification which can be located at <http://www.afosr.af.mil/oppts/afprop.htm>. The AFOSR Contract Certifications are to be submitted at the time of proposal submission. See instructions in subparagraph f. below.

(f) Proposal Narrative – Attach the proposal narrative to the SF 424 (R&R) cover sheet (for an application submitted through Grants.gov, electronically attach the proposal narrative at Field 20). The proposal narrative contains the abstract, technical proposal, budget and supplementary information as follows:

- **Abstract.** Include a concise (not to exceed 300 words) abstract that describes the instrumentation requested and the research and research-related education that will be supported by that instrumentation.
- **Technical Proposal.**
 - Describe in detail the research to be performed keeping in mind the evaluation criteria listed in Section V of this announcement.

-- Briefly address whether the intended research will result in environmental impacts outside the laboratory, and how the proposer will ensure compliance with environmental statutes and regulations.

- **Budget.** The financial portion of the proposal must contain a cost estimate for the proposed effort including a description of cost sharing arrangements, if any. It is anticipated that the awards will have an initial performance period of twelve months with two twelve month options, assuming a 1 January 2007 effective date. However, the start date is subject to negotiations. Individual budgets should be provided for each period. Should a grant be awarded AFOSR will make payment to educational and non-profit recipients based upon a predetermined payment schedule. Payments will normally be made quarterly in advance of performance, based upon a spending profile which must be provided as part of the proposal. Payments should be limited to the amounts needed to conduct research during each respective period. Educational and nonprofit organizations shall submit a spending profile with their cost proposal. For further details, proposers may refer to the "Proposer's Guide to AFOSR Research Programs"

(http://www.afosr.af.mil/ResearchAreas/funding_submitProp.htm).

- **Contract Certifications** –If using grants.gov for submission of proposals which will result in award of a contract, include the contract certifications at the end of your proposal narrative.

4. Other Submission Requirements

Proposals submitted in whole or in part by electronic media (computer disk or tape, facsimile machine, electronic mail, etc.) will not be accepted (unless the full proposal is submitted electronically through Grants.gov).

5. Human Subjects and Animal Use

a. Human Subjects. Each proposal must address human subject involvement in the research by addressing Field 1 and 1a of the R&R Other Project Information Form. If Field 1 indicates "Yes", the Air Force must receive a completed Optional Form 310 before a contract, grant, or cooperative agreement may be awarded to support research involving the use of human subjects. Attach the document to the R&R Other Project Information Form. If using grants.gov, a completed Optional Form 310 form shall be attached in field 11 of the R&R Other Project Information Form. The Optional Form 310 form is available electronically at:

http://www.afosr.af.mil/ResearchAreas/funding_submitProp.htm

b. Animal Use. Each proposal must address animal use protocols by addressing Field 2 and 2a of the R&R Other Project Information Form. If selected for award, additional documentation in accordance with Air Force standards will be required.

6. Application Receipt Notices.

a. For Electronic Submission - The applicant will receive a confirmation page upon completing the submission to Grants.gov. The applicant will receive an e-

mail within a few hours of submission indicating that the proposal has been validated by Grants.gov. (This means that all the required fields have been completed.) The third notice the applicant will receive is an e-mail from the designated agency to which the electronic proposal was submitted, to acknowledge receipt of the proposal and provide the agency's assigned tracking number. The email is sent to the authorized representative for the applicant institution approximately ten days from the proposal due date.

b. For Hard Copy Submission – An applicant that submits a hard copy proposal to AFOSR will receive an e-mail from the agency approximately ten days after the proposal due date to acknowledge receipt of the proposal and provide the agency's assigned tracking number. The e-mail is sent to the authorized representative for the applicant institution

7. Submission Dates and Times. This announcement will remain open through the remainder of FY07 or until replaced by a successor BAA. Proposals may be submitted at any time during that period.

V. Application Review Information

AFOSR's overriding purpose in supporting this research is to advance the state of the art in areas related to the technical problems the Air Force encounters in developing and maintaining a superior Air Force; lowering the cost and improving the performance, maintainability, and supportability of Air Force weapon systems; and creating and preventing technological surprise.

Proposals submitted under this BAA are evaluated through a peer or scientific review process, and selected for award on a competitive basis according to Public Law 98-369, Competition in Contracting Act of 1984, 10 USC 2361, and 10 USC 2374. Proposals may be evaluated by program managers at EOARD/AOARD and the appropriate AFRL Technology Directorates. Additionally, proposals may be evaluated by outside evaluators retained by AFOSR which may include support contractor personnel. Proposals submitted for Special Programs listed in Section I shall be evaluated under criteria as specified in their description. Subject to funding availability, all other proposals will be evaluated under the following two primary criteria, of equal importance, as follows:

1. The scientific and technical merits of the proposed research.
2. The potential contributions of the proposed research to the mission of the USAF.

Other evaluation criteria used in the technical reviews, which are of lesser importance than the primary criteria and of equal importance to each other, are:

1. The likelihood of the proposed effort to develop new research capabilities and broaden the research base in support of U.S. national defense.
2. The proposer's, principal investigator's, team leader's, or key personnel's qualifications, capabilities, related experience, facilities, or techniques or a combination of these factors that are integral to achieving USAF objectives.

3. The proposer's and associated personnel's record of past performance.
4. The realism and reasonableness of proposed costs.

No further evaluation criteria will be used in source selection. The technical and cost information will be analyzed simultaneously during the evaluation process.

For conference support, please see the evaluation criteria listed under the heading of "Conferences and Workshops" under Section I of this announcement.

Proposals may be submitted for one or more topics or for a specific portion of one topic. A proposer may submit separate proposals on different topics or different proposals on the same topic. The U.S. Government does not guarantee an award in each topic area. Further, be advised that as funds are limited, otherwise meritorious proposals may not be funded. Therefore, it is important that proposals show strength in as many of the evaluation area as practicable for maximum competitiveness.

Technology sharing and transfer is encouraged; in this respect, AFOSR welcomes proposals that envision university-industry cooperation. Non-industry proposers are encouraged to specify in their technical proposals their interactions with industry and the Air Force Research Laboratory's Technical Directorates, including specific points of contact. Cooperation with or use of facilities of the Air Force Research Laboratory is also encouraged. Personnel interaction (e.g., university faculty or students performing research at industry or Air Force Research Laboratory sites; industry or Air Force staff working in university laboratories) is viewed as highly desirable. Further information regarding the Air Force Research Laboratory may be viewed at <http://www.afrl.af.mil>.

VI. Award Administration Information

1. Award Notices.

Should your proposal be selected for award, the principal investigator will receive a letter from the Technical Directorate stating this information. This is not an authorization to begin work. Your business office will be contacted by the grant or contracting officer to negotiate the terms of your award.

2. Reporting Requirements.

Grants and cooperative agreements typically require annual and final technical reports, financial reports, and final patent reports. Contracts typically require annual and final technical and patent reports. Copies of publications and presentations should be submitted.

Additional deliverables may be required based on the research being conducted.

VII. Agency Contacts

Should you have questions about a technical research area, contact the program manager listed for the research topic areas listed in Section I. Should you have questions about the BAA or procedures for submission of a proposal, contact

VIII. Additional Information

1. For additional guidance on the form and content of proposals, proposers should refer to the "How to Apply for a Grant or Contract" selection, which is located in the "Doing Business with AFOSR" section of our World Wide Web site, <http://www.afosr.af.mil>.
2. The cost of proposal preparation in response to this Announcement is not considered an allowable direct charge to any resulting award. Such cost is, however, an allowable expense to the normal bid and proposal indirect cost specified in FAR 31.205-18, or OMB Circular A-21, Cost Principles for Educational Institutions or OMB Circular A-122, Cost Principles for Nonprofit Organizations.
3. Every effort will be made to protect the confidentiality of the proposal and any evaluations. The proposer must mark the proposal with a protective legend in accordance with FAR part 15.6, Use and Disclosure of Data, if protection is desired for proprietary or confidential information.
4. Only contracting or grants officers are legally authorized to bind the government.
5. Intellectual Property
 - a. Proposers shall identify all aspects of the intellectual property; technical data, hardware, and software that they plan to develop under this award for which the Government will acquire less than unlimited rights and to list specifically what the restrictions are. In the event that proposers do not submit such a list, the Government will assume that it automatically has unlimited rights to all intellectual property, technical data, hardware, and software developed under this award. Furthermore, the Government will assume that it has unlimited rights to all intellectual property, technical data, hardware, and software developed under this award that is not listed.
 - b. Proposers are advised that proposals containing restrictions on intellectual property are by nature less favorable and valuable to the government. Restrictions will be considered in the evaluation process. If no restrictions are intended, then the proposer should state this fact.
6. AFOSR documents are available on the AFOSR website at <http://www.afosr.af.mil>
7. Responses should reference Broad Agency Announcement AFOSR BAA 2007-01.
8. Prospective awardee shall be registered in the CCR database prior to award, during performance, and through final payment of any award resulting from this announcement. Offerors may obtain information on registration and annual

confirmation requirements via the Internet at <http://www.ccr.gov> or by calling 1-888-227-2423, or 269-961-5757.